Aviation History in Nepal

1949 : The date heralded the formal beginning of aviation in Nepal with the landing of a 4 seated lone powered vintage beach-craft Bonanza aircraft of Indianambassador Mr. Sarjit Singh Mahathia at Gauchar.
1950 : The first Charter flight By Himalayan Aviation Dakota From Goucher to Kolkata.
1955: King Mahendra inaugurated Gauchar Airport and renamed it as Tribhuwan Airport.
1957 : Grassy runway transformed into a concrete one.
1957 : Department of civil Aviation Founded.
1958: Royal Nepal Airlines started scheduled service domestically and externally.
1959 : RNAC fully owned by HMG/N as a public undertaking.
1960: Nepal Attained ICAO membership.
1964: Tribhuvan Airport renamed as Tribhuvan International Airport.
1967: The 3750 feet long runway extended to 6600 feet.
1967: Landing of the German Airlines Lufthansa Boeing 707.
1968: Thai International starts its scheduled jet air services.
1972: Nepalese jet aircraft Boeing 727/100 makes debut landing at TIA. ATC services taken over by Nepalese personnel from Indian Technicians.
1975: TIA runway extended to 10000 feet from the previous 6600 feet.
1975: CATC established.
1976 : FIC (Flight information Center) established.
1977: Nepal imprinted in the World Aeronautical.
1989: Completion of international Terminal Building and first Concorde.
1990: New International terminal Building Of TIA inaugurated by king Birendra.
1992 : Adoption of Liberal Aviation Policy and emergence of private sector in domestic air transport.
1993: National Civil Aviation Policy Promulgated.
1995: Domestic terminal Building of TIA and Apron expanded at TIA.
1998: COSCAP-SA project established.
2002: Expansion of the International Terminal Building at TIA and the construction of a new air cargo complex.
2003: Rara airport (Mugu), Kangeldandasirport (Solukhumbu) and Thamkharka airport (Khotand) brought in Operation.
2004: Domestic operation by jet aircraft commenced.
2005 : International Flight by two private operator began.
2006: A new comprehensive Aviation Policy introduced. GMG Airlines of Bangladesh, Korean Air and Air Arabia started air service to Nepal.
2007: Identification of site location for a new second international airport. Etihad, Dragon Air, Orient Thai and Hong Kong Express commenced their service to Nepal.
2009: Established of RCAG station at Nepalgunj to augment coverage of VHF communications in Air Traffic Control.
2010: An agreement of SDR 44388000 was signed between Nepal Government and CAAN for capacity Enhancement project of TIA under ADB loan.
2011: Tumlingtar and Simikot runways paved.
2012 : RNP AR procedures of TIA effected from June. AMHS commissioned in civil Aviation. CAA received TRAINAIR PLUS Associate Membership from ICAO.
2013: Installation of CNS & ATM Equipments at TIA to enhance ATC Capacity.
2014: Installation of terminal Monopulse secondary surveillance Radar (T-MSSR) at TIA and enroute MSSR at Bhattedada under Japanese Grant AID.
2015: Gautam Buddha International Airport foundation stone laid down by Hon' PM Sushil Korala. New Domestic Terminal Building Constructed at TIA. Total 23 Airports including TIA are paved till date.
2016: Pokhara Regional/Intl' Airport Construction Foundation Stone Laid down by Hon' PM K.P. Oli (2016 April 13).
2022: Gautam Buddha International Airport started scheduled international flights as second international airport in Nepal.

Civil Aviation Authority of Nepal (CAAN) Institutional Profile

Name:	Civil Aviation Authority of Nepal (CAAN)
Address:	Babarmahal, Kathmandu, Nepal Tel. 4262387, 4262326, 4262518 Fax:977-1-4262516

E-mail: dgca@caannepal.gov.np/cnsatm@mos.com.np URL: caanepal.gov.np

Type :	Authority

Date of Establishment: 31 December 1998

Legal Status: Civil Aviation Act, 2015 (1959 AD) - Statutory Regulations Civil Aviation Authority Act, 2053 (1996)- Establishment

Main Functions: Permitting Airlines Operation
Airworthiness Certification and Manpower Licensing/Rating Regulating Air Transport, Air Navigation Services (ATM/CNS), and Aerodromes as per ICAO SARPs.
Constructing, operating and maintaining airports
Equipping and maintaining airports with necessary communication and navigational facilities
Operation of safe, efficient & expeditious flight.

Affiliation/Institutional Linkages:
Ministry of Culture, Tourism & Civil Aviation, Ministry of Communication & Information Technology, Ministry of Home Affairs, Ministry of Finance, Ministry of Defense, Department of Hydrology & Meteorology, ICAO, COSCAP-SA, Airlines, NTB, International Funding Agencies, Travelling Public.

Income Resources:
Landing, Parking, Housing, Over-flying Navigation Charges, Security Charges, Charter Charges, Flight Catering Charges, Passenger Service Charges, Concessionaries; Vehicle Entry & Parking Charges, Advertisement Charges, Oil Throughput Charges, Terminal Rent, Land Rent, Royalty, Cargo Charges,
Regulatory fees, Ground Handling Charges, etc.

५. प्राधिकरणको काम, कर्तव्य र अधिकार (नेपाल नागरिक उड्डयन प्राधिकरण ऐन, २०५३) :

यस ऐनमा अन्यत्र लेखिएको काम, कर्तव्य र अधिकारको अतिरिक्त प्राधिकरणको काम, कर्तव्य र अधिकार देहाय बमोजिम हुनेछ :-

(क) प्रचलित कानून बमोजिम इजाजत प्राप्त वायुसेवा सञ्चालन संस्थाहरूलाई वायुसेवा सञ्चालन गर्न तोकिए बमोजिम अनुमति तथा प्रमाणपत्र प्रदान गर्ने, निलम्वन गर्ने वा रद्द गर्ने ।

(ख) प्रचलित कानून बमोजिम इजाजत प्राप्त हवाई उडान सम्बन्धी प्रशिक्षण संस्थाको सञ्चालन गर्न तोकिए बमोजिम अनुमति तथा प्रमाणपत्र प्रदान गर्ने, निलम्वन गर्ने वा रद्द गर्ने ।

(ग) प्रचलित कानून बमोजिम इजाजत प्राप्त वायुयान तथा वायुयानको पार्टपूर्जाहरूको उत्पादन, मर्मत तथा परीक्षण सहितको विस्तृत मर्मत (ओभरहल) गर्ने संस्थाहरूलाई तोकिए बमोजिम अनुमति दिने तथा त्यस्तो संस्थामा काम गर्ने प्राविधिज्ञलाई तोकिए बमोजिम इजाजत, कार्य क्षमताको स्तरीकरण (रेटिङ्ग) तथा प्रमाणपत्र दिने, नवीकरण गर्ने, रद्द गर्ने, स्थगित गर्ने, फिर्ता गर्ने तथा त्यस्तो इजाजत कार्य क्षमताको स्तरीकरण (रेटिङ्ग) र प्रमाणपत्र दिने सम्बन्धमा आवश्यक योग्यता तोक्ने तथा परीक्षा लिने ।

(घ) वायुसेवा सञ्चालनसंग सम्बद्ध तोकिए बमोजिमको योग्यता प्राप्त व्यक्तिहरूलाई तोकिए बमोजिम इजाजत, कार्य क्षमताको स्तरीकरण (रेटिङ्ग) तथा प्रमाणपत्र दिने, नवीकरण गर्ने, रद्द गर्ने, स्थगित गर्ने, फिर्ता गर्ने तथा त्यस्तो इजाजत कार्य क्षमताका स्तरीकरण (रेटिङ्ग) र प्रमाणपत्र दिने सम्बन्धमा आवश्यक योग्यता तोक्ने र परीक्षा लिने ।

(ङ) अन्तर्राष्ट्रिय नागरिक उड्डयन संगठनको सदस्य राष्ट्र वा त्यस्तो राष्ट्रबाट अधिकार प्राप्त संघ संस्थाबाट वायु सेवा सञ्चालनसंग सम्बन्धित विषयहरूमा प्रदान गरेको इजाजत, कार्य क्षमताको स्तरीकरण (रेटिङ्ग) तथा प्रमाणपत्रहरू र वायुयान मर्मत तथा परीक्षण सहितको विस्तृत मर्मत (ओभरहल) गर्ने संस्थालाई नेपाली वायुयानको मर्मत तथा परीक्षण सहितको विस्तृत मर्मत (ओभरहल) गर्न मान्यता दिने ।

(च) वायुयानको तोकिए बमोजिम दर्ता (रजिष्ट्रेशन) गर्ने र चिन्ह अंकित (मार्किङ्ग) गर्ने ।

(छ) वायुयानको तोकिए बमोजिम उडान योग्यताको प्रमाणपत्र (सर्टिफिकेट अफ एयरवर्दिनेश) दिने, नवीकरण गर्ने र खारेज गर्ने।

(ज) वायुयानको उडान, वायुयानबाट यात्रु, डाँक तथा मालसामान ओसार्ने र अन्य औद्योगिक व्यवसाय सम्बन्धी कामको निमित्त वायुयानको प्रयोग गर्न पाउने अवस्थाहरू तोक्ने ।

(झ) वायुयान, वायुयान राख्ने स्थान, वायुयान उडान तथा वायुयान सेवा सञ्चालन सम्बन्धी व्यवस्था र वायुयान मर्मत तथा परीक्षण सहितको विस्तृत मर्मत (ओभरहल) गर्ने स्थानको निरीक्षण गर्ने ।

(ञ) प्रचलित कानून बमोजिम नेपाल सरकारले निषेध गरेको क्षेत्र तथा स्थान बाहेक नेपाल अधिराज्यभित्र वायुयान प्रवेश गर्ने, नेपाल अधिराज्यबाट वायुयान प्रस्थान गर्ने, नेपाल अधिराज्यमाथि उडान गर्न पाउने अवस्था, हवाई मार्ग र वायुयान अवतरण गर्ने स्थानहरू तोक्ने ।

(ट) विमानस्थल तथा विमानस्थल क्षेत्रभित्र अग्नि निवारण तथा जीवनोद्धार सेवा उपलब्ध गराउने र खोज तथा उद्धार कार्यमा समन्वय गर्ने ।

(ठ) विमानस्थलमा भूमिस्थ सेवा (ग्राउण्ड ह्याण्डिलिंग) सेवा सञ्चालन गर्ने, गराउने ।

(ड) दृष्टिगत र यान्त्रिक उडान (भिजुयल एण्ड इन्टुस्मेण्ट फ्लाइट) गर्ने तथा हवाई मानचित्र (एरोनटिकल चार्टस्) को आवश्यकता तोक्ने, त्यस्तो मानचित्र तयारगर्ने तथा प्रचलन गर्ने र उडानको लागि मौसम सम्बन्धी सूचना आदान प्रदान गर्ने ।

(ढ) हवाई यातायात सेवा तथा सो सम्बन्धी विषयको प्राविधिक जाँचबुझ गर्न प्राधिकरणले आफ्नो वायुयान राख्ने र प्रयोग गर्ने।

(ण) हवाई उडान सेवा (एयर ट्राफिक सर्भिस), हवाई उडान सूचना सेवा (फ्लाइट इन्फर्मेशन सर्भिस), सचेत गर्ने सेवा (एलर्टिङ्ग सर्भिस), हवाई उडान सल्लाह सेवा
(एयर ट्राफिक एडभाइजरी सर्भिस), हवाई उडान नियन्त्रण सेवा (एयर ट्राफिक कन्ट्रोल सर्भिस) र हवाई पथ प्रदर्शन सेवा तथा सुविधा (एयर नेभिगेशन सर्भिस तथा फेसिलिटिज), क्षेत्र नियन्त्रण सेवा (एरिया कन्ट्रोल सर्भिस), पहुँच क्षेत्र नियन्त्रण सेवा (एप्रोच कन्ट्रोल सर्भिस) तथा विमानस्थल नियन्त्रण सेवा (एरोड्रम कन्ट्रोल सर्भिस) उपलब्ध गराउने ।
(त) हवाई सञ्चार सम्बन्धमा प्रयोग गरिने नापको इकाई तोक्ने, वायुयानद्वारा वा वायुयानमा सन्चारको निमित्त प्रयोग गरिने संकेत र त्यस्तो संकेत दिंदा प्रयोग हुने यन्त्र तोक्ने ।
(थ) वायुयानको आवाज नियन्त्रण गर्ने र वायुयान सन्चालनबाट वायुमण्डल तथा वातावरणमा हुने प्रदूषणमा रोक लगाउने ।
(द) खतराजन्य वस्तु तथा पदार्थहरूको वायुयानद्वारा ओसार पसार गर्न निषेध तथा नियन्त्रण गर्ने र परिमाण तोक्ने ।
(ध) हवाई उडान अनुमति प्रदान गर्ने र वायुयानका चालकहरूको काम, कर्तव्य, उडान तथा विश्राम समय तोक्ने ।
(न) हवाई यातायात सेवा सञ्चालनमा लाग्ने यात्रु तथा मालसामानको ढुवानीको भाडा दस्तूर निर्धारण गर्ने सम्बन्धमा नेपाल सरकारलाई सुझाव दिने ।
(प) विमानस्थल, विमानस्थल क्षेत्र र त्यहाँ उपलब्ध सेवा सुविधाहरूलाई अधिकतम आर्थिक लाभ र सदुपयोग हुने गरी तोकिए बमोजिम प्रयोग गर्ने वा गर्ने दिने ।

(फ) अन्तर्राष्ट्रिय नागरिक उड्डयन सम्बन्धी महासन्धि (कन्भेन्सन) बाट पारित भई नेपाल सरकारबाट अनुमोदन भएको र सो महासन्धि अन्तर्गत बनेको तथा अन्तर्राष्ट्रिय नागरिक उड्डयन संगठन (आई.सि.ए.ओ.) बाट निर्धारित मापदण्ड (स्ट्याण्डर्डस्) र सिफारिशहरू (परिशिष्ट तथा दस्तावेज) आदि आवश्यकतानुसार लागू गर्ने, गराउने ।
(ब) प्राधिकरणको स्वामित्वमा रहेको भवन, वायुयान, यन्त्र, उपकरण आदि सम्पत्तिको आवश्यकतानुसार विमा गर्ने ।
(भ) नेपाल सरकारले तोकेका अन्य कार्यहरू गर्ने, गराउने ।

The International Civil Aviation Organization

The most important international agency concerned with air- port development is the International Civil Aviation Organization (ICAO), which is now a specialized agency of the United Nations with headquarters in Montreal, Canada. There are currently 193 member states of ICAO (as of 2019)
The ICAO concept was formed during a conference of 52 nations held in Chicago in 1944. This conference was by the invitation of the United States to consider matters of mutual interest in the field of air transportation.

The objectives of ICAO as stated in its charter are to develop the principles and techniques of international air transportation so as to

1. **Ensure the safe and orderly growth of international civil aviation throughout the world**
2. **Encourage the arts of aircraft design and operation for peaceful purposes**
3. **Encourage the development of airways, airports, and air navigation facilities for international aviation**
4. **Meet the needs of the peoples of the world for safe, regular, efficient, and economical air transport**
5. **Prevent economic waste by unreasonable competition**
6. **Ensure that the rights of contracting states are fully respected and that every contracting state has a fair opportunity to operate international airlines**
7. **Avoid discrimination between contracting states**
8. **Promote safety of flight in international air navigation**
9. **Promote generally the development of all aspects of international civil aeronautics**

The ICAO has two governing bodies, the Assembly and the Council.

The ICAO Assembly is the Organization's sovereign body. It meets at least once every three years and is convened by ICAO's governing body, the Council.

ICAO's 193 Member States and a large number of international organizations are invited to the Assembly, which establishes the worldwide policy of the Organization for the upcoming triennium.

During Assembly Sessions, ICAO's complete work programme in the technical, economic, legal and technical cooperation fields is reviewed in detail. Assembly outcomes are then provided to the other bodies of ICAO and to its Member States in order to guide their continuing and future work, as prescribed in Article 49 of the Convention on International Civil Aviation.

Each Member State is entitled to one vote on matters before the Assembly, and decisions at these Sessions are taken by a majority of the votes cast – except where otherwise provided for in the Convention.
The Council is a permanent body responsible to the Assembly and is composed of representatives from 36 countries. President of the Council is **Mr. Salvatore Sciacchitano (2020-2022).**

Montréal, 1 August 2021 – Mr. Juan Carlos Salazar of Colombia officially assumed the office of ICAO Secretary General today, succeeding Dr. Fang Liu of China.

The Council is the working group for the organization. It carries out the directives of the Assembly and discharges the duties and obligations specified in the ICAO charter.

To the airport planner and designer perhaps the most important document issued by ICAO is "Aerodromes," Annex 14 to the Convention on International Civil Aviation. Annex 14 contains the international design standards and recommended practices which are applicable to nearly all airports serving international air commerce.

The economic, political and social roles of airports

The economic benefits of air transport

Air transport generates employment and wealth

Direct, indirect and induced impacts on employment

Air transport generates wider catalytic (spin-off) benefits

Ability to serve larger markets Impact on business operations

Influence on investment

Impact on the labour market

Value of air transport's wider catalytic impacts

Air transport contributes to world trade

The value of international trade Airfreight's role in international trade

Passenger air services' role in international trade

The importance of passenger air services to companies

Air transport stimulates tourism

Benefits of tourism

Air transport's role in supporting tourism

Employment and GDP in tourism

Air transport is a significant tax payer

Levying user charges

Levying taxation

Contributing to public funds in the developed world

The social benefits of air transport

-Contributes to sustainable development

Promoting international tourism. Tourism helps reduce poverty by generating economic growth, providing employment opportunities, increasing tax collection, and by fostering the development and conservation of protected areas and the environment.

-Provides access to remote areas

-Delivers humanitarian aid

- Contributes to consumer welfare

Travel and tourism provide substantial consumer welfare and social benefits.

• Increasing understanding of different cultures and nationalities

• Improving living standards by widening choice – easy and fast delivery of goods and consumables worldwide at cheap price.

Air transport improves quality of life by broadening people's leisure and cultural experiences. It provides a wide choice of holiday destinations around the world and an affordable means to visit distant friends and relatives.

Air transport helps to improve living standards and alleviate poverty, for instance, through tourism.

Air transport may provide the only transportation means in remote areas, thus promoting social inclusion.

Air transport contributes to sustainable development. By facilitating tourism and trade, it generates economic growth, provides jobs, increases revenues from taxes, and fosters the conservation of protected areas.

The air transport network facilitates the delivery of emergency and humanitarian aid relief anywhere on earth, and ensures the swift delivery of medical supplies and organs for transplantation.

Political Roles

Politics is a set of activities associated with the governance of a country or an area. It involves making decisions that apply to group of members.

A major commercial airport is a huge public enterprise. Some are literally cities in their own right, with a great variety of facilities and services. Although the administrative functions and responsibilities of these facilities are governed by public entities, airports are also comprised of private dispositions. Commercial airports must be operated in cooperation with the air carriers that provide air transportation service and all airports must work with tenants, such as concessionaires, fixed-based operators (FBOs), and other firms doing business on airport property. This amalgamation of public management and private enterprise fashions a unique political role for airport management.

- Airline carrier-airport relationships

- Concessionaire-airport relationships

- General aviation-airport relationships
- Airport-public relationship

The airport has many organizations who are profoundly interested in their operations, and in developing and preserving airports due to their role in the national air transportation system and their value to the communities and publics they serve. The primary goal of these groups is to provide political support for their causes with hopes to influence federal, state, and local laws concerning airports and aviation operations in their favour.

The Airport System

It is divided into two major components, the airside and the landside. The aircraft gates at the terminal buildings form the division between the two components.

Airside Elements

→Runway(s) [and Stopway(s)]
- ↗Runway shoulders
- ↗Runway strips
- ↗Runway end safety area
- ↗Clearways

→Taxiway(s)
- ↗Taxiway shoulders
- ↗Taxiway strips

→Apron(s)
- ↗Aircraft Parking Apron
- ↗Cargo Apron
- ↗General Aviation Apron
- ↗Helicopter Apron

→Holding bay(s)

→Isolated Aircraft Parking Area

→Airfield Drainage

→Airport Periphery Road

→Aerodrome Control Tower

→Buildings for Radio Navigation Aids

→Electrical Sub-stations

→Rescue and Fire Fighting Complexes

→Aircraft Maintenance Hangars

Land side elements

→Terminals
- ↗Passenger Terminals
- ↗Cargo Terminals
- ↗General Aviation Terminal

→Administration and Maintenance Buildings

→Meteorological Services Building

→Flight Catering Building

→Fuel Farm

→Airport Hotels

→Power/Generator Houses

→Sewerage Treatment and Pump Stations

→Security Fences and Control Gates

→Car Parks

→Access Roads

The Airport System Plan

An airport system plan is a representation of the aviation facilities required to meet the immediate and future needs of a metropolitan area, region, state, or country.

The system plan presents the recommendations for the general location and characteristics of new airports and heliports and the nature of expansion for existing ones to meet forecasts of aggregate demand. It identifies the aviation role of existing and recommended new airports and facilities. It includes the timing and estimated costs of development and relates airport system planning to the policy and objectives of the relevant jurisdiction. Its overall purpose is to deter- mine the extent, type, nature, location, and timing of airport develop- ment needed to establish a viable, balanced, and integrated system of airports.

The elements in a typical airport system planning pro-cess include the following:

10. Exploration of issues that impact aviation in the study area
11. Inventory of the current system
12. Identification of air transportation needs
13. Forecast of system demand
14. Consideration of alternative airport systems
15. Definition of airport roles and policy strategies
16. Recommendation of system changes, funding strategies, and airport development
17. Preparation of an implementation plan

AIRPORT MASTER PLAN

An airport Master Plan represents a guide as to how the airport development should be provided to meet the foreseen demand while maximising and preserving the ultimate capacity of the site.

It is necessary to actually construct each of the planned facilities only when an increasing volume of traffic justifies it. Therefore the Master Plan of an airport should include the plan of the phasing of the stages of building.

Master Plan of an airport is only a guideline, and not a program of construction. Therefore it does not solve details of design.

In a financial plan, which is included in Master Plan, it is only possible to make approximate analyses of alternatives for development. The Master Plan determines the strategy of development but not a detailed plan of how to ensure financing of each of the construction stages.

A. An airport master plan is a guide for:
□ **development of airport facilities, for aeronautical and non-aeronautical services**
□ **development of land uses for adjacent areas**
□ **environmental impact assessment**
□ **establishing of access requirements for the airport**

B. Beside others an airport master plan is used to:
□ provide guidance for long and short term planning
□ identify potential problems and opportunities
□ be a tool for financial planning
□ serve as basis for negotiation between the airport management and concessionaires
□ for communication with local authorities and communities

Types of actions during the airport master planning
A. Policy/co-ordinative planning:
□ setting project objectives and aims
□ preparing project work programs, schedules and budgets
□ preparing an evaluation and decision format

□ establishing co-ordination and monitoring procedures
□ establishing data management and information system
B. Economic planning
□ preparing market outlooks and market forecasts
□ determining cost benefit of alternative schemes
□ preparing assessment of catchment area impact study of alternative schemes
C. Physical planning
□ system of air traffic control and airspace organization
□ airfield configuration including approach zones
□ terminal complex
□ utility communication network and circulation
□ supporting and service facilities
□ ground access system
□ over-all land use patterns
D. Environmental planning
□ preparing of an environmental impact airport assessment

□ project development of the impact area
□ determining neighbouring communities' attitudes and opinions
E. Financial planning
□ determining of airport development financing
□ preparing financial feasibility study of alternative
□ preparing preliminary financial plans for the finally approved project alternative

Steps in the planning process

1. Preparing a master planning work programme
2. Inventory and documentation of existing conditions
3. Future air traffic demand forecast
4. Determining gross facility requirements and preliminary time-phased development of same
5. Assessing existing and potential constraints
6. Agree upon relative importance or priority of various elements:
   + airport type
   + constraints
   + political and other considerations
7. Development of several conceptual or master plan alternatives for purpose of comparative analysis
8. Review and screen alternative conceptual plans. Provide all interested parties with an opportunity to test each alternative
9. Selection of the preferred alternative, development of this alternative and preparing it in final form

Plan update recommendations

A. Master plan and/or specific elements should be reviewed at least biennially and adjusted as appropriate to reflect conditions at the time of review

B. Master plan should be thoroughly evaluated and modified every five years, or more often if changes in economic, operational, environmental and financial conditions indicate an earlier need for such revision.

A master plan report is typically organized as follows:

Master plan vision, goals, and objectives—establishes the vision and overarching goals for the master plan as well as objectives that will guide the planning process and help ensure that the goals are achieved and the vision is realized.

Inventory of existing conditions—provides an overview of the air- port's history, role in the region and nation, growth and devel- opment over time, description of its physical assets (airfield and airspace, terminal, ground access, and support facilities), and key industry trends.

Forecast of aviation demand—future levels of aircraft operations, number of passengers, and volume of cargo are forecasted for short, intermediate, and long-range time periods. Typically fore- casts are made for 5, 10, and 20 years on both annual as well daily and busiest hours of the day.

Demand/capacity analysis and facility requirements—compares the future demand with the existing capacity of each airport compo- nent and identifies the facility requirements necessary to accom- modate the demand.

Alternatives development—identifies, refines, and evaluates a range of alternatives for accommodating facility requirements. If the existing site cannot accommodate the anticipated growth, a selec- tion process to find a new site may be necessary.

Preferred development plan—identifies, describes, and defines the alternative that best achieves the master plan goals and objectives.

Implementation plan—provides a comprehensive plan for the imple- mentation of the preferred development plan, including the definition of projects, construction sequence and timeline, cost estimates, and financial plan.

Environmental overview—provides an overview of the anticipated environmental impacts associated with the preferred develop- ment plan in order to understand the severity and to help expe- dite subsequent environmental processing at the project specific stage.

Airport plans package—documents that show the existing as well as planned modifications are prepared and the more notable is the airport layout plan (ALP). It comprises drawings that include the airfield's physical facilities, obstruction clearance and runway approach profiles, land-use plans, terminal area and ground access plans, and a property map. Specific guidelines for the airport layout plan in the United States are identified by FAA.

Stakeholder and public involvement—documents the coordina- tion efforts that occur among the stakeholders throughout the study.

Strategic Plans

In the field of management, *strategic planning* refers to a disciplined process for analyzing the current situation of a business activity, and identifying the vision of how that entity should position itself regarding its customers and competitors Airport managers and operators need to think strategically.

They need to examine the range of future possibilities, position their organizations to respond flexibly to the events that occur, and in fact react appropriately as the future becomes clear.

Good strategic thinking for an airport must consider the context of the airport/ airline industry. Events far beyond the airport boundaries affect the development and consequently the planning for airports.

Decisions made in faraway airline boardrooms can drastically upset airport developments. For example, US Airways' decision to consolidate its operations in Philadelphia turned Pittsburgh's airport into a "ghost town." Traffic at this former hub dropped from

19.8 million annual passengers in 2001 to only 8.0 million in 2010. Similarly, when American Airlines bought TWA and closed its hub in St. Louis, traffic there dropped from 30.6 million annual passengers to 12.4 million in just 4. years .. Likewise, . the decisions by Emirates to expand aggressively, and of Dubai to provide enormous new airport facilities, are causing shifts in traffic flows affecting major European hubs. Airports must look beyond their boundaries when they do their planning. Airport planners need to take a systems view that looks at the larger airport/ airline industry.

Forecasting

Plans for the development of the various components of the airport ystem depend to a large extent on the activity levels which are forecast for the future. Since the purpose of an airport is to process aircraft, passengers, freight, and ground transport vehicles in an efficient and safe manner, airport performance is judged on the basis of how well the demand placed upon the facilities within the system is handled.

To adequately assess the causes of performance breakdowns in existing airport systems and to plan facilities to meet future needs, it is essential to predict the level and distribution of demand on the various components of the airport system. Without a reliable knowledge of the nature and expected variation in the loads placed upon a component, it is impossible to realistically assess the physical and operational requirements of such a component. For example, a forecast to project the mix of aircraft and the types of aviation activity at an airport site is necessary to identify the critical aircraft which dictates the elements of geometric and structural design, the type and extent of physical facilities, the navigational aid requirements, and any special or unique facility needs at the airport.

Over the years, certain techniques have evolved which enable airport planners and designers to forecast future demand. The principal items for which estimates are usually needed include

- The volume and peaking characteristics of passengers, aircraft, vehicles, and cargo
- The number and types of aircraft needed to serve the above traffic
- The number of based general aviation aircraft and the number of movements generated
- The performance and operating characteristics of ground access systems

There are four major methods of Forecasting :

- Time series method
- Market share method
- Econometric modeling
- Simulation modelling

Accuracy and Limitations of Forecasting.

Geometric Design of Aerodromes

ICAO Annex 14 Vol I (Aerodromes) Chapters:

CHAPTER ONE: GENERAL (Definitions, Applicability, Aerodrome reference code)
CHAPTER TWO: AERODROME DATA
CHAPTER THREE: PHYSICAL CHARACTERISTICS
CHAPTER FOUR: OBSTACLE RESTRICTION AND REMOVAL
CHAPTER FIVE: VISUAL AIDS FOR NAVIGATION (Indicators, Markings, Lights)
CHAPTER SIX: VISUAL AIDS FOR DENOTING OBSTACLES
CHAPTER SEVEN: VISUAL AIDS FOR DENOTING RESTRICTED USE AREAS
CHAPTER EIGHT: ELECTRICAL SYSTEMS
CHAPTER NINE: AERODROME OPERATIONAL SERVICES, EQUIPMENT AND INSTALLATIONS
CHAPTER TEN: AERODROME MAINTENANCE

Definitions

Aerodrome reference code

Content from ICAO Annex 14

1.6.1 An aerodrome reference code — code number and letter — which is selected for aerodrome planning purposes shall be determined in accordance with the characteristics of the aeroplane for which an aerodrome facility is intended.

1.6.2 The aerodrome reference code numbers and letters shall have the meanings assigned to them in Table 1-1.

1.6.3 The code number for element 1 shall be determined from Table 1-1, column 1, selecting the code number corresponding to the highest value of the aeroplane reference field lengths of the aeroplanes for which the runway is intended.

1.6.4 The code letter for element 2 shall be determined from Table 1-1, by selecting the code letter which corresponds to the greatest wingspan, of the aeroplanes for which the facility is intended.

Table 1-1. Aerodrome reference code

(see 1.6.2 to 1.6.4)

Code element 1	
Code number	Aeroplane reference field length
1.	Less than 800 m
2.	800 m up to but not including 1200 m
3.	1200 m up to but not including 1800 m
4.	1800 m and over

Code element 2	
Code letter	Wingspan
•	up to but not including 15 m
•	15 m up to but not including 24 m
•	24 m up to but not including 36 m
•	36 m up to but not including 52 m
•	52 m up to but not including 65 m
•	65 m up to but not including 80 m

Contents from Aerodrome Design Manual Part I

Factors affecting the sitting, orientation and number of runway

2.1.1 Many factors affect the determination of the siting, orientation and number of runways. The more important factors are:
a) weather, in particular the runway/aerodrome usability factor, as determined by **wind** distribution, and **the occurrence of localized fogs**;
b) topography of the aerodrome site and its surroundings;
c) type and amount of **air traffic** to be served, including air traffic control aspects;
d) aeroplane performance considerations; and
e) environmental considerations, particularly noise.

2.1.2 The primary runway, to the extent other factors permit, should be oriented in the direction of the prevailing wind. All runways should be oriented so that approach and departure areas are free of obstacles and, preferably, so that aircraft are not directed over populated areas.
2.1.3 The number of runways must be sufficient to meet air traffic demands, which consist of the number of aircraft arrivals and departures, and the mixture of aircraft types, to be accommodated in one hour during the busiest periods. The decision as to the total number of runways to be provided should also take into account the aerodrome usability factor and economic considerations.
2.1.6 The number and orientation of runways at an aerodrome should be such that the usability factor of the aerodrome is not less than 95 per cent for the aeroplane that the aerodrome is intended to serve.
2.1.7 In the application of the 95 per cent usability factor it should be assumed that landing or take-off of aeroplanes is, in normal circumstances, precluded when the cross-wind component exceeds:
— 37 km/h (20 kt) in the case of aeroplanes whose reference field length is 1 500 m or over, except that when poor runway braking action owing to an insufficient longitudinal coefficient of friction is experienced with some frequency, a cross-wind component not exceeding 24 km/h (13 kt) should be assumed;
— 24 km/h (13 kt) in the case of aeroplanes whose reference field length is 1 200 m or up to but not including 1 500 m; and
— 19 km/h (10 kt) in the case of aeroplanes whose reference field length is less than 1 200 m.

3.1 FACTORS AFFECTING THE LENGTH OF RUNWAYS

3.1.1 Factors which have a bearing on the runway length to be provided are:
a) performance characteristics and operating masses of the aeroplanes to be served;
b) weather, particularly surface wind and temperature;
c) runway characteristics such as slope and surface condition; and
d) aerodrome location factors, for example, aerodrome elevation which affects the barometric pressure and topographical constraints.

The greater the head wind down a runway, the shorter the runway length required by an aeroplane taking off or landing. Conversely, a tail wind increases the length of runway required. The higher the temperature, the longer the runway required because higher temperatures create lower air densities resulting in lower output of thrust and reduced lift.

3.2 ACTUAL LENGTH OF RUNWAYS

Primary runways

3.2.1 Except where a runway is associated with a stopway and/or clearway, the actual runway length to be provided for a primary runway should be adequate to meet the operational requirements of the aeroplanes for which the runway is intended and should be not less than the longest length determined by applying the corrections for local conditions to the operations and performance characteristics of the relevant aeroplanes.

Secondary runways

3.2.4 The length of a secondary runway should be determined similarly to primary runways except that it needs only to be adequate for those aeroplanes which require to use that secondary runway in addition to the other runway or runways in order to obtain a usability factor of at least 95 per cent.

3.3 RUNWAYS WITH STOPWAYS AND/OR CLEARWAYS

3.3.1 Where a runway is associated with a stopway or clearway, an actual runway length less than that resulting from application of 3.2.2 or 3.2.3, as appropriate, may be considered satisfactory, but in such a case any combination of runway, stopway and/or clearway provided should permit compliance with the operational requirements for take- off and landing of the aeroplanes the runway is intended to serve.

3.4 CALCULATION OF DECLARED DISTANCES

3.4.1 The introduction of stopways and clearways and the use of displaced thresholds on runways has created a need for accurate information regarding the various physical distances available and suitable for the landing and take-off of aeroplanes. For these purposes, the term “declared distances” is used with the following four distances associated with a particular runway:
a) Take-off run available (TORA), i.e. the length of runway declared available and suitable for the ground run of an aeroplane taking off.
b) Take-off distance available (TODA), i.e. the length of the take-off run available plus the length of the clearway, if provided.
c) Accelerate stop distance available (ASDA), i.e. the length of the take-off run available plus the length of the stopway, if provided.

d) Landing distance available (LDA), i.e. the length of runway which is declared available and suitable for the ground run of an aeroplane landing.

3.4.3 Where a runway is not provided with a stopway or clearway and the threshold is located at the extremity of the runway, the four declared distances should normally be equal to the length of the runway as shown in Figure 3-1A.

3.4.4 Where a runway is provided with a clearway (CWY), then the TODA will include the length of clearway as shown in Figure 3-1B.

3.4.5 Where a runway is provided with a stopway (SWY), then the ASDA will include the length of stopway as shown in Figure 3-1C.

3.4.6 Where a runway has a displaced threshold, then the LDA will be reduced by the distance the threshold is displaced as shown in Figure 3-1D. A displaced threshold affects only the LDA for approaches made to that threshold; all declared distances for operations in the reciprocal direction are unaffected.

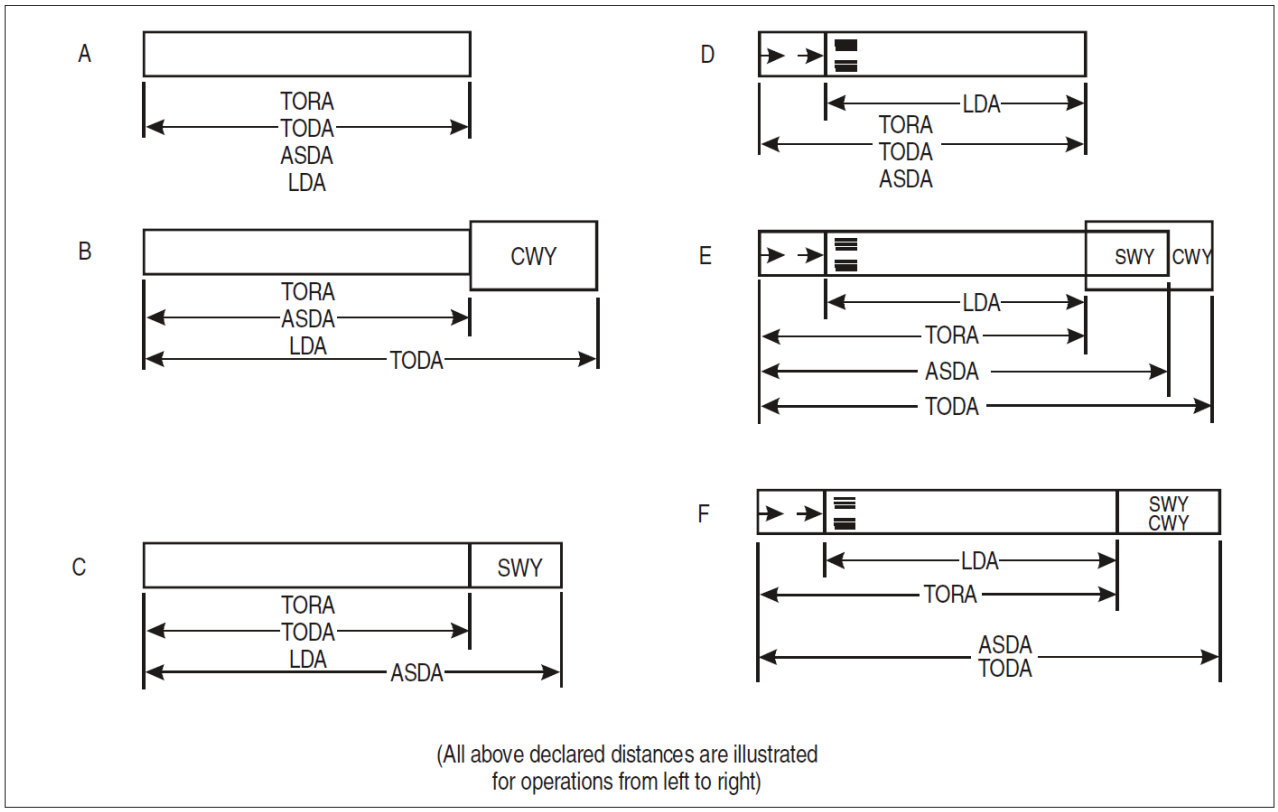


Figure 3-1. Illustration of declared distances

3.5 RUNWAY LENGTH CORRECTIONS FOR ELEVATION, TEMPERATURE AND SLOPE

3.5.1 As stated in 3.2.3, when the appropriate flight manual is not available the runway length must be determined by applying general correction factors.

As a first step, a basic length should be selected for the runway adequate to meet the operational requirements of the aeroplanes for which the runway is intended.

This basic length is a runway length selected for aerodrome planning purposes which is required for take-off or landing under standard atmospheric conditions for zero elevation, zero wind and zero runway slope.

3.5.2 **The basic length selected for the runway should be increased at the rate of 7 per cent per 300 m elevation.**

3.5.3 The length of runway determined under 3.5.2 should be further increased at the rate of 1 per cent for every 1°C by which the aerodrome reference temperature exceeds the temperature in the standard atmosphere for the aerodrome elevation (see Table 3-1).

If, however, the total correction for elevation and temperature exceeds 35 per cent, the required corrections should be obtained by means of a specific study.

The operational characteristics of certain aeroplanes may indicate that these correction constants for elevation and temperature are not appropriate, and that they may need to be modified by results of aeronautical study based upon conditions existing at the particular site and the operating requirements of such aeroplanes.

3.5.4 Where the basic length determined by take-off requirements is 900 m or over, **that length should be further increased at the rate of 10 per cent for each 1 per cent of the runway slope** as defined in 5.1.4.

Example of the application of runway length corrections

a) Data:

1)	runway length required for landing at sea level in standard atmospheric conditions	2 100 m
2)	runway length required for take-off at a level site at sea level in standard atmospheric conditions	2 500 m
3)	aerodrome elevation	150 m
4)	aerodrome reference temperature	24°C
5)	temperature in the standard atmosphere for 150 m	14.025°C
6)	runway slope	0.5%

b) Correction to runway take-off length:

1) runway take-off length corrected for elevation =

$$\left[2\,500 \times 0.07 \times \frac{150}{300}\right] + 2\,500 = \quad 2\,588 \text{ m}$$

2) runway take-off length corrected for elevation and temperature =

$$[2\,588 \times (24 - 14.025) \times 0.01\ ] + 2\,588 = \quad 2\,846 \text{ m}$$

3) runway take-off length corrected for elevation, temperature and slope =

$$[2\,846 \times 0.5 \times 0.10\ ] + 2\,846 = \quad 2\,988 \text{ m}$$

c) Correction to runway landing length:
runway landing length corrected for elevation =

$$\left[2\,100 \times 0.07 \times \frac{150}{300}\right] + 2\,100 = \quad 2\,174 \text{ m}$$

d) Actual runway length = 2 988 m

AEROPLANE PERFORMANCE PARAMETERS AFFECTING RUNWAY LENGTH

OPERATIONAL TERMS

a) ***Decision speed*** **(V_1)** is the speed chosen by the operator at which the pilot, having recognized a failure of the critical engine, decides whether to continue the flight or initiate the application of the first retarding device. If the engine failure occurs before the decision speed is reached, the pilot should stop; if failure occurs later, the pilot should not stop but should continue the take-off.

b) ***Take-off safety speed*** **(V_2)** is the minimum speed at which the pilot is allowed to climb after attaining a height of 10.7 m (35 ft) to maintain at least the minimum required climb gradient above the take-off surface during a take-off with one engine inoperative.

c) ***Rotation speed*** **(V_R)** is the speed at which the pilot initiates rotation of the aeroplane to cause raising of the landing gear.

d) ***Lift-off speed*** **(V_{LOF})** in terms of calibrated airspeed, is the speed at which the aeroplane first becomes airborne.

4.2 TAKE-OFF LENGTH REQUIREMENT

4.2.1 The aeroplane performance operating limitations require a length which is enough to ensure that the aeroplane can, after starting a take-off, either be brought safely to a stop or complete the take-off safely. For the purpose of discussion it is supposed that the runway, stopway and clearway lengths provided at the aerodrome are only just adequate for the aeroplane requiring the longest take-off and accelerate-stop distances, taking into account its take-off mass, runway characteristics and ambient atmospheric conditions.

Under these circumstances, there is for each take-off, a speed, called the decision speed (V_1); below this speed, the take-off must be abandoned if an engine fails, while above it the take-off must be completed.

A very long take-off run and take-off distance would be required to complete a take-off when an engine fails before the decision speed is reached because of the insufficient speed and the reduced power available.

There would be no difficulty in stopping in the remaining accelerate-stop distance available provided action is taken immediately. In these circumstances the correct course of action would be to abandon the take-off.

4.2.2 On the other hand, if an engine fails after the decision speed is reached, the aeroplane will have sufficient speed and power available to complete the take-off safely in the remaining take-off distance available. However, because of the high speed, there would be difficulty in stopping the aeroplane in the remaining accelerate-stop distance available.

4.2.10 Taking as a schematic illustration (Figure 4-1 (a)) the case of an aeroplane standing at the entrance end A of a runway, the pilot starts the take-off, the aeroplane accelerates and approaches the decision speed (V_1) point B. A sudden and complete failure of an engine is assumed to occur and is recognized by the pilot as the decision speed (V_1) is attained. The pilot can either:

— brake until the aeroplane comes to a standstill at point Y (the accelerate-stop distance); or

— continue accelerating until reaching the rotation speed (V_R), point C, at which time the aeroplane rotates and becomes airborne at the lift-off speed (V_{LOF}), point D, after which it reaches the end of the take-off run, point X, and continues to the 10.7 m (35 ft) height at the end of the take-off distance, point Z.

4.2.12 The engine-inoperative take-off and accelerate-stop distances will vary according to the selection of the decision speed (V_1). If the decision speed is reduced, the distance to point B (Figure 4-1 (a)) is reduced, as is the accelerate-stop distance; but the take-off run and take-off distances are increased as a larger part of the take-off manoeuvre is carried out with an engine inoperative. Figure 4-2 illustrates the probable relationship which may exist between the accelerate-stop distances, the take-off distances, and the take-off runs with respect to variations in the decision speed, (V_1), within the limits stated in 4.1.1.

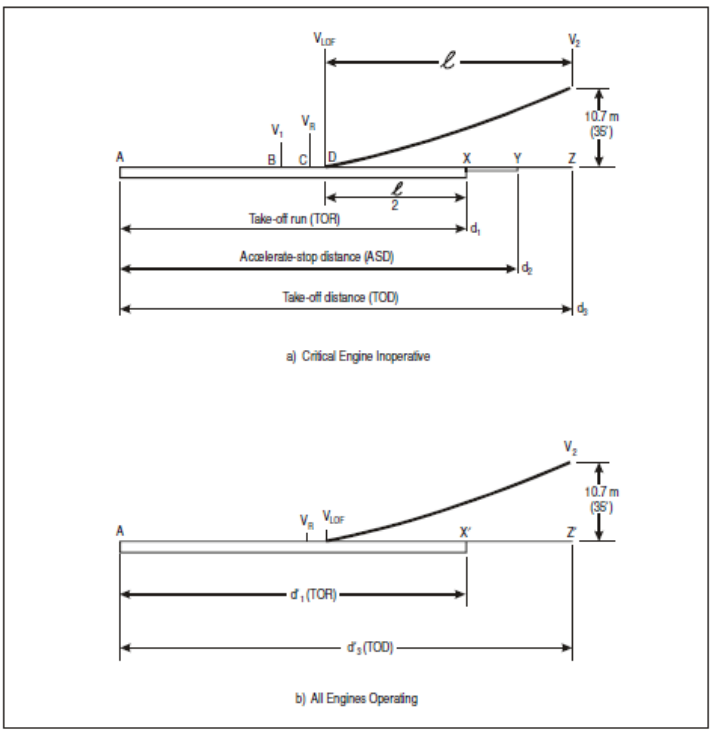


Figure 4-1.

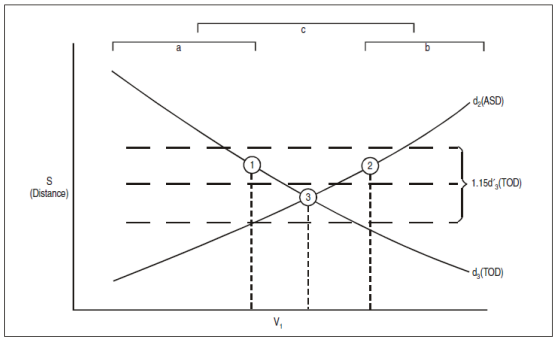


Figure 4-2.

4.2.18 The runway length determined from the take-off performance charts is the greater of either:

a) the balanced field length, that is, the runway length required when the take-off distance with one engine inoperative and accelerate-stop distance are equal; or

b) 115 per cent of the take-off distance with all engines operative.

4.3 LANDING LENGTH REQUIREMENT

Although landing lengths are normally not critical, aeroplane landing performance charts should be consulted to check that runway length requirements for take-off provide adequate runway length for landing.

In general a landing length is determined that provides for an aeroplane landing after clearing all obstacles in the approach path by a safe margin and stopping safely. Allowance shall be made for variations in the approach and landing techniques of particular aeroplanes, if such allowance has not been made in the scheduling of performance data. The runway length determined from a landing performance chart is the aeroplane's landing distance required divided by 0.6. Where the length of runway required for landing is greater than that required for the take-off run, this will determine the minimum length of runway required.

Aerodrome Physical Characteristics (Contents from ICAO Annex 14)

Runway

Actual length of runways

3.1.7 Primary runway Recommendation.- *Except as provided in 3.1.9 the actual runway length to be provided for a primary runway should be adequate to meet the operational requirements of the aeroplanes for which the runway is intended and should be not less than the longest length determined by applying the corrections for local conditions to the operations and performance characteristics of the relevant aeroplanes.*

3.1.9 Runways with stopways or clearways

Recommendation.- *Where a runway is associated with a stopway or clearway, an actual runway length less than that resulting from application of 3.1.7 or 3.1.8, as appropriate, may be considered satisfactory, but in such a case any combination of runway, stopway and clearway provided should permit compliance with the operational requirements for take-off and landing of the aeroplanes the runway is intended to serve.*

Width of runways

3.1.10 The width of a runway shall not be less than the appropriate dimension specified in the following tabulation: Outer Main Gear Wheel Span (OMGWS)

Code number	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
1a	18 m	18 m	23 m	-
2a	23 m	23 m	30 m	-
3	30 m	30 m	30 m	45 m
4	-	-	45 m	45 m

a. The width of a precision approach runway should be not less than 30 m where the code number is 1 or 2.

Factors affecting the width of runway (Content from Aerodrome Design Manual Part I)

The factors affecting the width of runways are:
a) deviation of an aeroplane from the centre line at touchdown;
b) cross-wind condition;
c) runway surface contamination (e.g. rain, snow, slush or ice);
d) rubber deposits;
e) crab landing approaches used in cross-wind conditions;
f) approach speeds used;
g) visibility; and
h) Human Factors.

Minimum distance between parallel runways

3.1.11 Where parallel non-instrument runways are intended for simultaneous use, the minimum distance between their centre lines shall be:
- 210 m where the higher code number is 3 or 4;
- 150 m where the higher code number is 2; and
- 120 m where the higher code number is 1

3.1.12 Where parallel instrument runways are intended for simultaneous use subject to conditions specified in the PANS-ATM (Doc 4444) and the ICAO PANS-OPS (Doc 8168), Volume 1, the minimum distance between their centre lines shall be:
- 1 035 m for independent parallel approaches;
- 915 m for dependent parallel approaches;
- 760 m for independent parallel departures;
- 760 m for segregated parallel operations;

Slopes on runways

3.1.13 Longitudinal slopes

Recommendation.- T*he slope computed by dividing the difference between the maximum and minimum elevation along the runway centre line by the runway length should not exceed:*
- 1 per cent where the code number is 3 or 4; and
- 2 per cent where the code number is 1 or 2.

3.1.18 Distance between slope changes

Recommendation.- *Undulations or appreciable changes in slopes located close together along a runway should be avoided. The distance between the points of intersection of two successive curves should not be less than:*

a) the sum of the absolute numerical values of the corresponding slope changes multiplied by the appropriate value as follows:

- 30 000 m where the code number is 4;

- 15 000 m where the code number is 3; and

- 5 000 m where the code number is 1 or 2; or

b) 45 m;

whichever is greater.

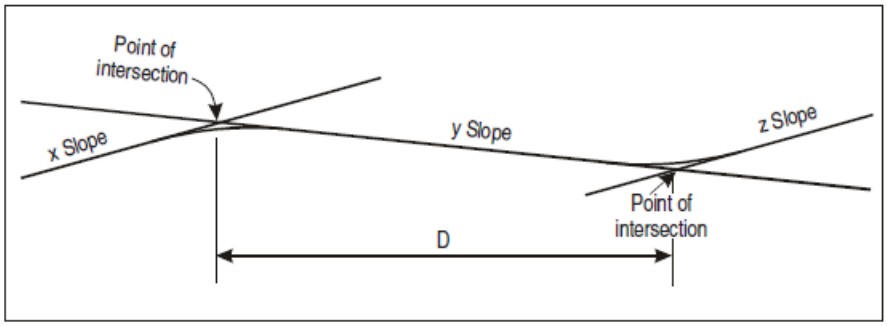


Figure 5-2. Profile on centre line of runway

D for a runway where the code number is 3 should be at least
15 000 [|x-y| + |y-z|] m

|x-y| being the absolute numerical value of x-y

|y-z| being the absolute numerical value of y-z

Assuming x = +0.01
y = -0.005
z = +0.005
then |x-y| = 0.015

|y-z| = 0.01

To comply with the specifications, D should be not less than:

15 000 (0.015 + 0.01) m,
that is, 15 000 × 0.025 = 375 m

3.1.19 Transverse slopes

Recommendation.- *To promote the most rapid drainage of water, the runway surface should, if practicable, be cambered except where a single crossfall from high to low in the direction of the wind most frequently associated with rain would ensure rapid drainage. The transverse slope should ideally be:*

- 1.5 per cent where the code letter is C, D, E or F; and
- 2 per cent where the code letter is A or B;

3.2 Runway shoulders

Width of runway shoulders

3.2.2 For aeroplanes with OMGWS from 9 m up to but not including 15 m, the runway shoulders shall extend symmetrically on each side of the runway so that the overall width of the runway and its shoulders is not less than:

- 60 m where the code letter is D or E;
- 60 m where the code letter is F with two- or three-engined aeroplanes; and
- 75 m where the code letter is F with four (or more) - engined aeroplanes.

Slopes on runway shoulders

3.2. 3 **Recommendation.-** *The surface of the shoulder that abuts the runway should be flush with the surface of the runway and its transverse slope should not exceed 2.5 per cent.*

3.3 Runway turn pads

General

3.3.1 Where the end of a runway is not served by a taxiway or a taxiway turnaround and where the code letter is D, E or F, a runway turn pad shall be provided to facilitate a 180-degree turn of aeroplanes. (See Figure 3-1.)

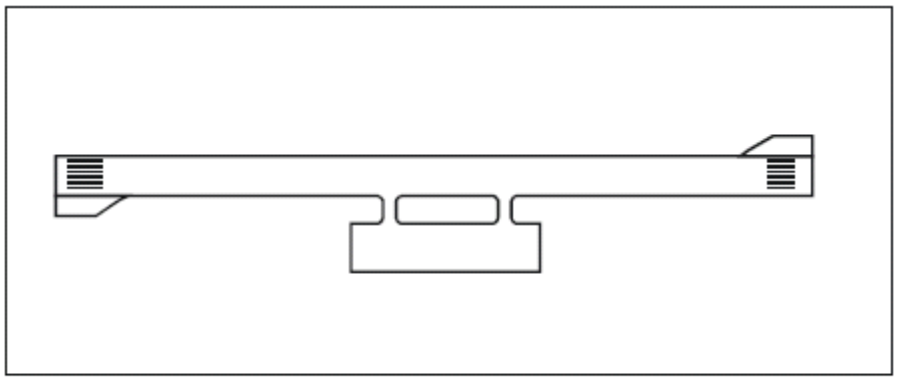


Figure 3-1. Typical turn pad layout

$R_{180° \text{ turn}} = b \tan (90 - b) + t/2$
where b = wheelbase of an aircraft
t = wheel track of the aircraft
b= maximum steering angle

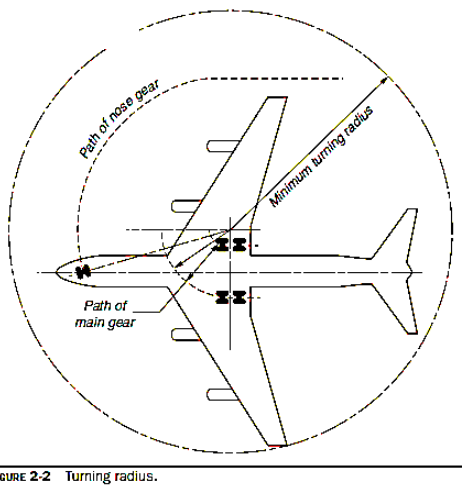


FIGURE 2-2 Turning radius.

3.4 Runway strips

General

3.4.1 A runway and any associated stopways shall be included in a strip.

Length of runway strips

3.4.2 A strip shall extend before the threshold and beyond the end of the runway or stopway for a distance of at least:

- 60 m where the code number is 2, 3 or 4;
- 60 m where the code number is 1 and the runway is an instrument one; and
- 30 m where the code number is 1 and the runway is a non-instrument one.

Width of runway strips

3.4.3 A strip including a precision approach runway shall, wherever practicable, extend laterally to a distance of at least:

- 140 m where the code number is 3 or 4; and

- 70 m where the code number is 1 or 2;

on each side of the centre line of the runway and its extended centre line throughout the length of the strip.

3.4.5 **Recommendation.-** A strip including a non-instrument runway should extend on each side of the centre line of the runway and its extended centre line throughout the length of the strip, to a distance of at least:

- 75 m where the code number is 3 or 4;
- 40 m where the code number is 2; and
- 30 m where the code number is 1.

Grading of runway strips

3.4.8 **Recommendation.-** *That portion of a strip of an instrument runway within a distance of at least:*

- 75 m where the code number is 3 or 4; and
- 40 m where the code number is 1 or 2;

from the centre line of the runway and its extended centre line should provide a graded area for aeroplanes which the runway is intended to serve in the event of an aeroplane running off the runway.

3.4.15 Transverse slopes

Recommendation.- *Transverse slopes on that portion of a strip to be graded should be adequate to prevent the accumulation of water on the surface but should not exceed:*

- 2.5 per cent where the code number is 3 or 4; and
- 3 per cent where the code number is 1 or 2;

5.3.11 For a precision approach runway it may be desirable to adopt a greater width where the code number is 3 or 4. Figure 5-3 shows the shape and dimensions of a wider strip that may be considered for such a runway. (Aerodrome Design Manual Part I)

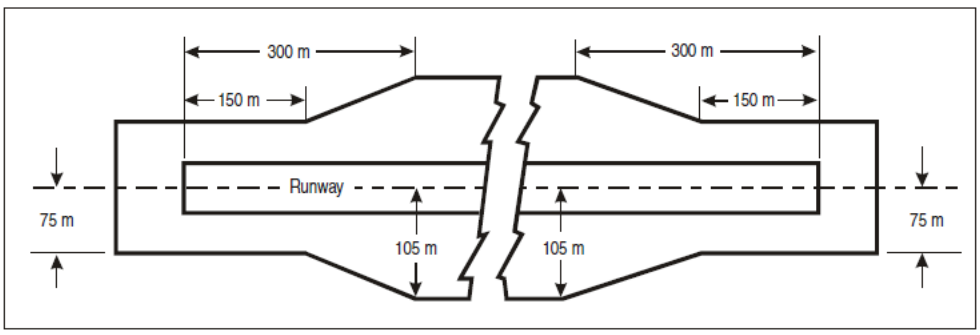


Figure 5-3. Graded portion of a strip including a precision approach runway where the code number is 3 or 4

3.5 Runway end safety areas

General

3.5.1 A runway end safety area shall be provided at each end of a runway strip where:
- the code number is 3 or 4; and

- the code number is 1 or 2 and the runway is an instrument one.

Dimensions of runway end safety areas

3.5.3 A runway end safety area shall extend from the end of a runway strip to a distance of at least 90 m.where:
— the code number is 3 or 4; and

— the code number is 1 or 2 and the runway is an instrument one.

3.5.4 **Recommendation.—** *A runway end safety area should, as far as practicable, extend from the end of a runway strip to a distance of at least:*
— 240 m where the code number is 3 or 4; or a reduced length when an arresting system is installed;

— 120 m where the code number is 1 or 2 and the runway is an instrument one; or a reduced length when an arresting system is installed; and

— 30 m where the code number is 1 or 2 and the runway is a non-instrument one.

3.5.5 The width of a runway end safety area shall be at least twice that of the associated runway.

3.6 Clearways

Location of clearways

3.6.1 **Recommendation.-** *The origin of a clearway should be at the end of the take-off run available.*

Length of clearways

3.6.2 **Recommendation.-** *The length of a clearway should not exceed half the length of the take-off run available.*

Width of clearways

3.6.3 **Recommendation.-** *A clearway should extend laterally on each side of the extended centre line of the runway to a distance of at least:*
a) 75 m on each side of the extended centre line of the runway.
b) half of the width of the runway strip for non-instrument runways.

3.7 Stopways

Width of stopways

3.7.1 A stopway shall have the same width as the runway with which it is associated.

TAXIWAYS *(Aerodrome Design Manual Part 2)*

Functional requirements

The separate and distinct aerodrome functional elements are linked by the taxiway system. The components of the taxiway system therefore serve to link the aerodrome functions and are necessary to develop optimum aerodrome utilization.

The taxiway system should be designed to minimize the restriction of aircraft movement to and from the runways and apron areas. A properly designed system should be capable of maintaining a smooth, continuous flow of aircraft ground traffic at the maximum practical speed with a minimum of acceleration or deceleration. This requirement ensures that the taxiway system will operate at the highest levels of both safety and efficiency.

In planning the general layout of the taxiway system, the following principles should be considered:

a) taxiway routes should connect the various aerodrome elements by the shortest distances, thus minimizing both taxiing time and cost;

b) taxiway routes should be as simple as possible in order to avoid pilot confusion and the need for complicated instructions;

c) straight runs of pavement should be used wherever possible. Where changes in direction are necessary, curves of adequate radii, as well as fillets or extra taxiway width, should be provided to permit taxiing at the maximum practical speed (see Section 1.4 and Appendix 1);
d) taxiway crossings of runways and other taxiways should be avoided whenever possible in the interests of safety and to reduce the potential for significant taxiing delays;
e) taxiway routings should have as many one-way segments as possible to minimize aircraft conflicts and delay. Taxiway segment flows should be analysed for each configuration under which runway(s) will be used;

Types of Taxiways –
Entry/Exit Taxiways
Parallel Taxiways
Apron Taxiway
Aircraft Stand Taxilane
Rapid Exit Taxiway (RET)

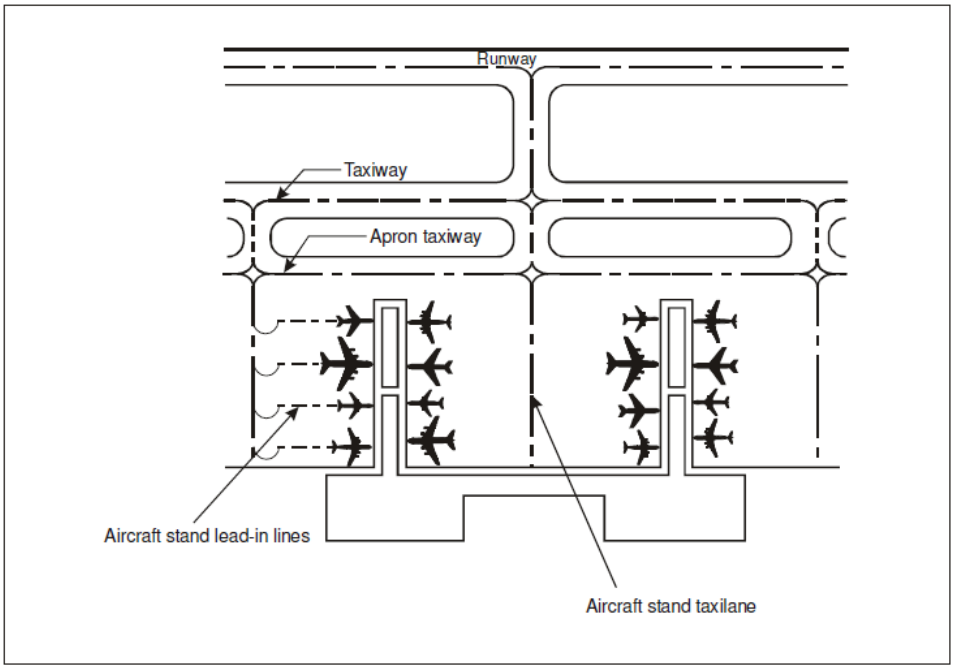


Figure 1-1. Taxiways on aprons

3.4 SIZE OF APRONS

General

3.4.1 The amount of area required for a particular apron layout depends upon the following factors:

a) the size and manoeuvrability characteristics of the aircraft using the apron;
b) the volume of traffic using the apron;
c) clearance requirements;
d) type of ingress and egress to the aircraft stand;

3.9 Taxiways (From Annex 14)

3.9.1 Taxiways shall be provided to permit the safe and expeditious surface movement of aircraft.

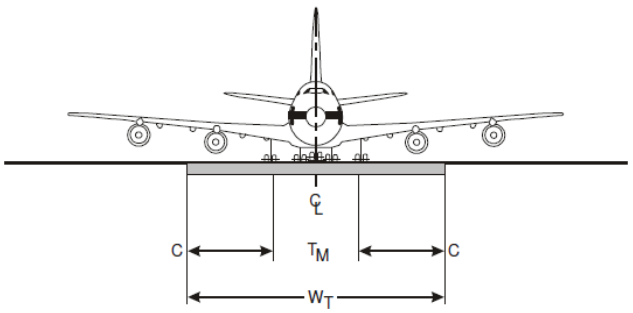


Figure 1-18. Taxiway width geometry

3.9.2 Sufficient entrance and exit taxiways for a runway shall be provided to expedite the movement of aeroplanes to and from the runway and provision of rapid exit taxiways considered when traffic volumes are high

.

3.9.3 The design of a taxiway shall be such that, when the cockpit of the aeroplane for which the taxiway is intended remains over the taxiway centre line markings, the clearance distance between the outer main wheel of the aeroplane and the edge of the taxiway shall be not less than that given by the following tabulation:

OMGWS

	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
Clearance	1.50 m	2.25 m	3 m[a, b] or 4 m[c]	4 m

Width of taxiways

3.9.4 A straight portion of a taxiway shall have a width of not less than that given by the following tabulation:

	OMGWS			
	Up to but not including 4.5 m	4.5 m up to but not including 6 m	6 m up to but not including 9 m	9 m up to but not including 15 m
Taxiway width	7.5 m	10.5 m	15 m	23 m

$W_T = T_M + 2C$

where:

T_M = maximum outer main gear wheel span

C = clearance between the outer main gear wheel and the taxiway edge (maximum allowable lateral deviation).

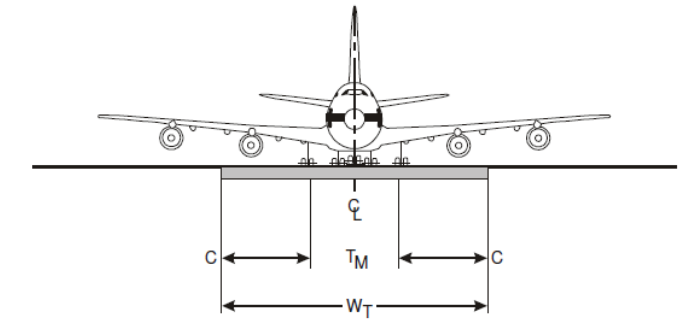


Figure 1-18. Taxiway width geometry

Taxiway curves

3.9.5 **Recommendation.-** *Changes in direction of taxiways should be as few and small as possible. The radii of the curves should be compatible with the manoeuvring capability and normal taxiing speeds of the aeroplanes for which the taxiway is intended. The design of the curve should be such that, when the cockpit of the aeroplane remains over the taxiway centre line markings, the clearance distance between the outer main wheels of the aeroplane and the edge of the taxiway should not be less than those specified in 3.9.3.*

Junctions and intersections

3.9.6 **Recommendation.-** *To facilitate the movement of aeroplanes, fillets should be provided at junctions and intersections of taxiways with runways, aprons and other taxiways. The design of the fillets should ensure that the minimum wheel clearances specified in 3.9.3 are maintained when aeroplanes are manoeuvring through the junctions or intersections.*

1.3 RAPID EXIT TAXIWAYS (RETS) (Content from AD Manual Part 2) General

1.3.1 A rapid exit taxiway is a taxiway connected to a runway at an acute angle and designed to allow landing aeroplanes to turn off at higher speeds than those achieved on other exit taxiways, thereby minimizing runway occupancy time.

1.3.2 A decision to design and construct a rapid exit taxiway is based upon analyses of existing and contemplated traffic. The main purpose of these taxiways is to minimize aircraft runway occupancy and thus increase aerodrome capacity. When the design peak hour traffic density is approximately less than 25 operations (landings and take-offs), the right angle exit taxiway may suffice. The construction of this right angle exit taxiway is less expensive, and when properly located along the runway, achieves an efficient flow of traffic.

Rapid exit taxiways (Content from Annex 14)

3.9.15 **Recommendation.-** *A rapid exit taxiway should be designed with a radius of turn-off curve of at least:*

- 550 m where the code number is 3 or 4; and
- 275 m where the code number is 1 or 2;

to enable exit speeds under wet conditions of:

- *93 km/h where the code number is 3 or 4; and*
- 65 km/h where the code number is 1 or 2.

3.9.16 **Recommendation.-** *The radius of the fillet on the inside of the curve at a rapid exit taxiway should be sufficient to provide a widened taxiway throat in order to facilitate early recognition of the entrance and turn-off onto the taxiway.*

3.9.17 **Recommendation.-** *A rapid exit taxiway should include a straight distance after the turn-off curve sufficient for an exiting aircraft to come to a full stop clear of any intersecting taxiway.*

3.9.18 **Recommendation.-** *The intersection angle of a rapid exit taxiway with the runway should not be greater than 45° nor less than 25° and preferably should be 30°.*

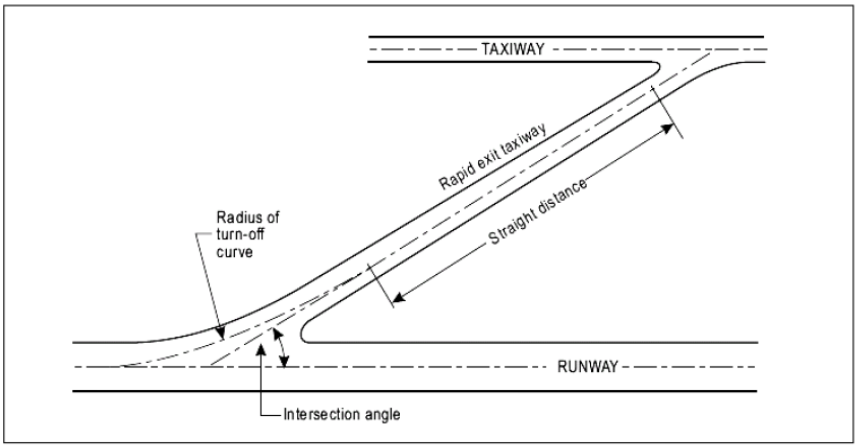


Figure 3-3. Rapid exit taxiway

Design of rapid exit taxiways (Content from AD Manual Part 2)
1.3.12 Using the **Three Segment Method**, the total distance required from the landing threshold to the point of turn-off from the runway centre line can be determined according to the method illustrated in Figure 1-15.
The total distance S is the sum of three distinct segments which are computed separately.

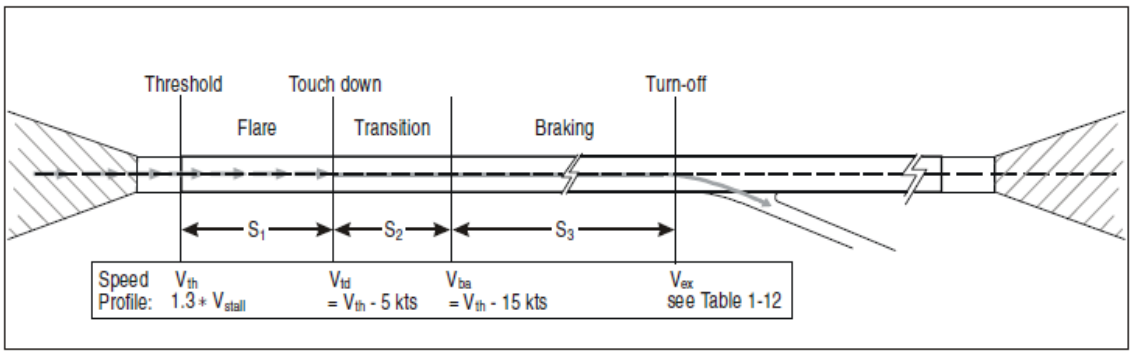


Figure 1-15. Three segment method

Segment 1: Distance required from landing threshold to maingear touchdown (S1).

Segment 2: Distance required for transition from maingear touchdown to establish stabilized braking configuration (S2).

Segment 3: Distance required for deceleration in a normal braking mode to a nominal turnoff speed (S3).

Holding Bay
Holding bay. A defined area where aircraft can be held, or bypassed, to facilitate efficient surface movement of aircraft.

2.1 NEED FOR HOLDING BAYS AND OTHER BYPASSES
Aerodromes with single taxiways and no holding bays or other bypasses provide aerodrome control units with no opportunity to change the sequence of departures once the aircraft have left the apron. In particular, at aerodromes with large apron areas, it is often difficult to arrange for aircraft to leave the apron in such a way that they will arrive at the end of the runway in the sequence required by air traffic services units.

2.1.2 The provision of an adequate number of holding bay spaces or other bypasses, based upon an analysis of the

current and near-term hourly aircraft departure demand, will allow a large degree of flexibility in generating the departure sequence. This provides air traffic services units with greater flexibility in adjusting the take-off sequence to overcome undue delays, thus increasing the capacity of an aerodrome. In addition, holding bays or other bypasses allow:

a) departure of certain aircraft to be delayed owing to unforeseen circumstances without delaying the following aircraft (for instance, a last minute addition to the payload or a replacement of defective equipment);

b) aircraft to carry out pre-flight altimeter checks and alignment and programming of airborne inertial navigation systems when this is not possible on the apron;

c) engine runups for piston aircraft; and

d) establishment of a VOR aerodrome check-point.

2.2 TYPES OF BYPASSES

2.2.1 In general, taxiway features that allow an aircraft to bypass a preceding aircraft can be divided into three types:

a) Holding bays. A defined area where aircraft can be held or bypassed. Figure 2-1 shows some examples of holding bay configurations and Figure 2-2 gives a detailed example of a holding bay, located at the taxi-holding position.

b) Dual taxiways. A second taxiway or a taxiway bypass to the normal parallel taxiway. Figure 2-3 shows some examples.

c) Dual runway entrances. A duplication of the taxiway entrance to the runway. Some examples are shown in Figure 2-4.

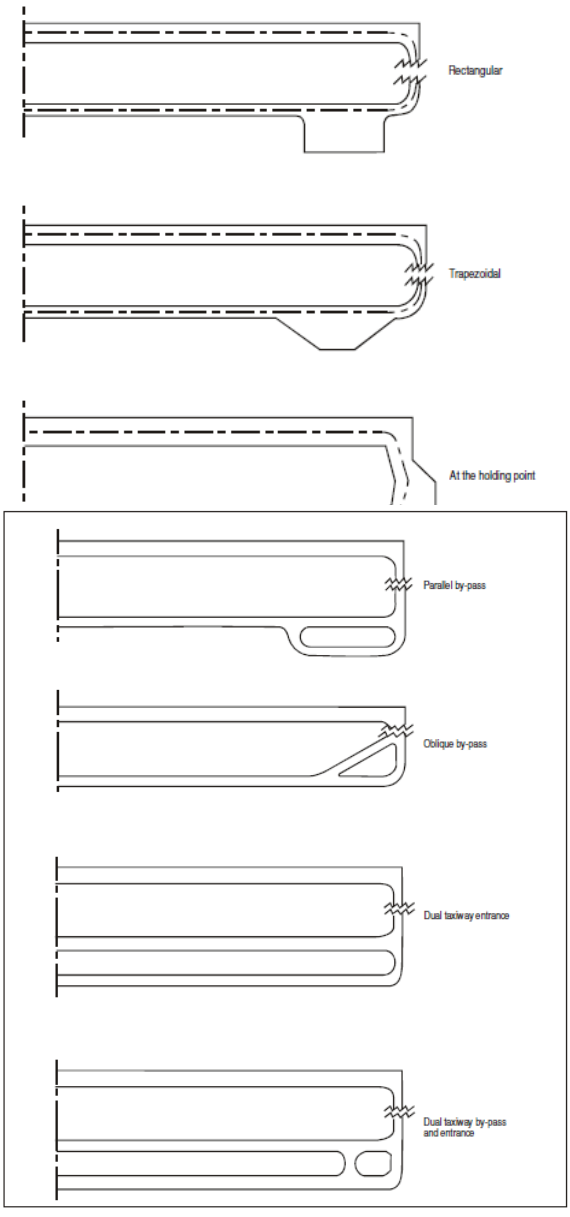


Figure 2-3. Examples of dual taxiways

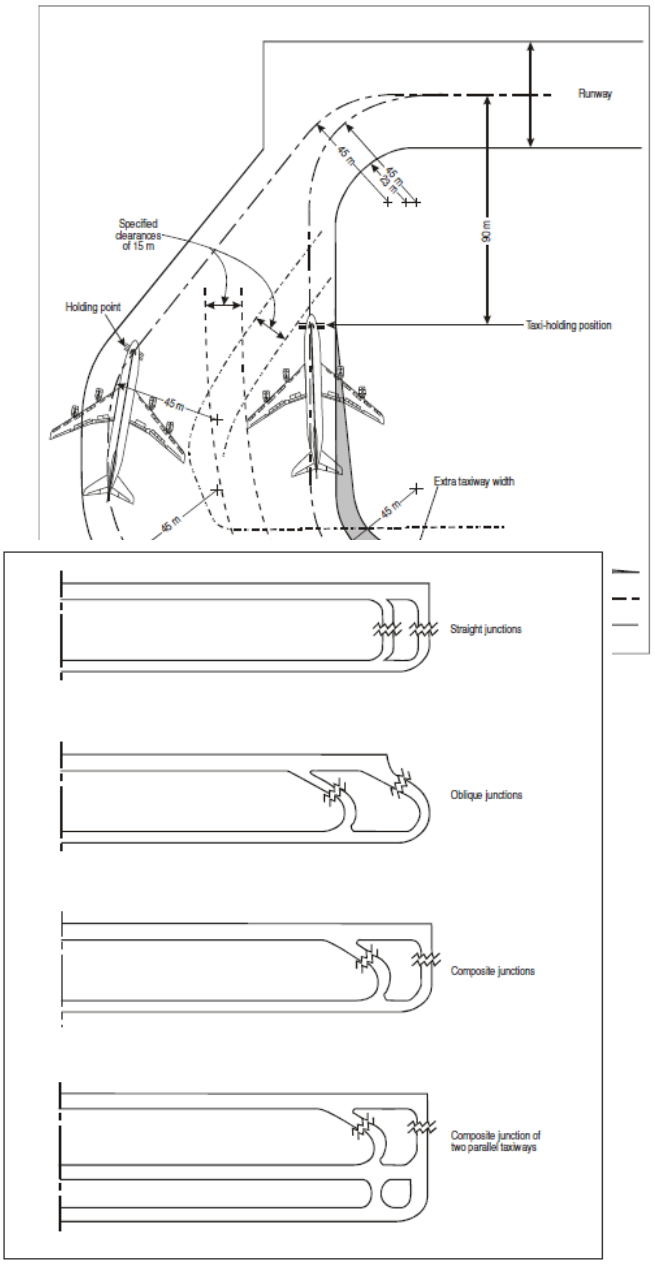


Figure 2-4. Examples of dual runway entrances

2.3 COMMON DESIGN REQUIREMENTS AND CHARACTERISTICS

2.3.1 Regardless of the type of bypass used, minimum centre line to centre line separations between taxiways and runways must be maintained as required for the type of runway served (see Table 1-1).

2.4 SIZE AND LOCATION OF HOLDING BAYS

2.4.1 The space required for a holding bay depends on the number of aircraft positions to be provided, the size of the aircraft to be accommodated and the frequency of their utilization. The dimensions must allow for sufficient space between aircraft to enable them to manoeuvre independently.

The information given in Chapter 3 on size of aircraft stands also applies to holding bays. In general, the wing tip clearance (increment) between a parked aircraft and one moving along the taxiway or apron taxiway should not be less than that given by the following tabulation:

Code letter	Wing tip clearance (increment) (m)
A	7.25
B	7.25
C	5
D	10
E	10.5
F	13.0

2.4.2 When used to allow flexible departure sequencing, the most advantageous location for a holding bay is adjacent to the taxiway serving the runway end. Other locations along the taxiway are satisfactory for aircraft performing pre-flight checks or engine runups or as a holding point for aircraft awaiting departure clearance.

APRONS

An apron is a defined area intended to accommodate aircraft for purposes of loading and unloading passengers, mail or cargo, fuelling and parking or maintenance. The apron is generally paved but may occasionally be unpaved; for example, in some instances, a turf parking apron may be adequate for small aircraft.

3.1 TYPES OF APRONS (Contents from Aerodrome Design Manual Part 2)

Passenger terminal apron

3.1.1 The passenger terminal apron is an area designed for aircraft manoeuvring and parking that is adjacent or readily accessible to passenger terminal facilities. This area is where passengers board the aircraft from the passenger terminal. In addition to facilitating passenger movement, the passenger terminal apron is used for aircraft fuelling and maintenance as well as loading and unloading cargo, mail and baggage. Individual aircraft parking positions on the passenger terminal apron are referred to as aircraft stands.

Cargo terminal apron

3.1.2 Aircraft that carry only freight and mail may be provided a separate cargo terminal apron adjacent to a cargo terminal building. The separation of cargo and passenger aircraft is desirable because of the different types of facilities each requires both on the apron and at the terminal.

Remote parking apron

3.1.3 In addition to the terminal apron, airports may require a separate parking apron where aircraft can park for extended periods. These aprons can be used during crew layovers or for light periodic servicing and maintenance of temporarily grounded aircraft. While parking aprons are removed from the terminal aprons, they should be located as close to them as is practical to minimize the time for passenger loading/unloading as well as from a security point of view.

Service and hangar aprons

3.1.4 A service apron is an uncovered area adjacent to an aircraft hangar on which aircraft maintenance can be performed, while a hangar apron is an area on which aircraft move into and out of a storage hangar.

General aviation aprons

3.1.5 General aviation aircraft, used for business or personal flying, require several categories of aprons to support different general aviation activities.

Itinerant apron

3.1.5.1 Itinerant (transient) general aviation aircraft use the itinerant apron as temporary aircraft parking facilities and to access fuelling, servicing and ground transportation. At aerodromes servicing only general aviation aircraft, the itinerant apron is usually adjacent to, or an integral part of, a fixed-based operator's area. The terminal apron will generally also set aside some area for itinerant general aviation aircraft.

Base aircraft aprons or tiedowns

3.1.5.2 General aviation aircraft based at an aerodrome require either hangar storage or a tiedown space in the open. Hangared aircraft also need an apron in front of the building for manoeuvring. Open areas used for base aircraft tiedown may be paved, unpaved or turf, depending on the size of aircraft and local weather and soil conditions. It is desirable that they be in a separate location from the itinerant aircraft aprons.

Other ground servicing aprons

3.1.5.3 Areas for servicing, fuelling or loading and unloading should also be provided as needed.

3.2 DESIGN REQUIREMENTS

3.2.1 The design of any of the various apron types requires the evaluation of many interrelated and often contradictory characteristics. Despite the distinct purposes of the different apron types, there are many general design characteristics relating to **safety, efficiency, geometry, flexibility** and engineering that are common to all types.

3.13 Aprons (Contents from Annex 14)

General

3.13.1 **Recommendation.-** *Aprons should be provided where necessary to permit the on- and off-loading of passengers, cargo or mail as well as the servicing of aircraft without interfering with the aerodrome traffic.*

Size of aprons

3.13.2 **Recommendation.-** *The total apron area should be adequate to permit expeditious handling of the aerodrome traffic at its maximum anticipated density.*

3.3 BASIC TERMINAL APRON LAYOUTS

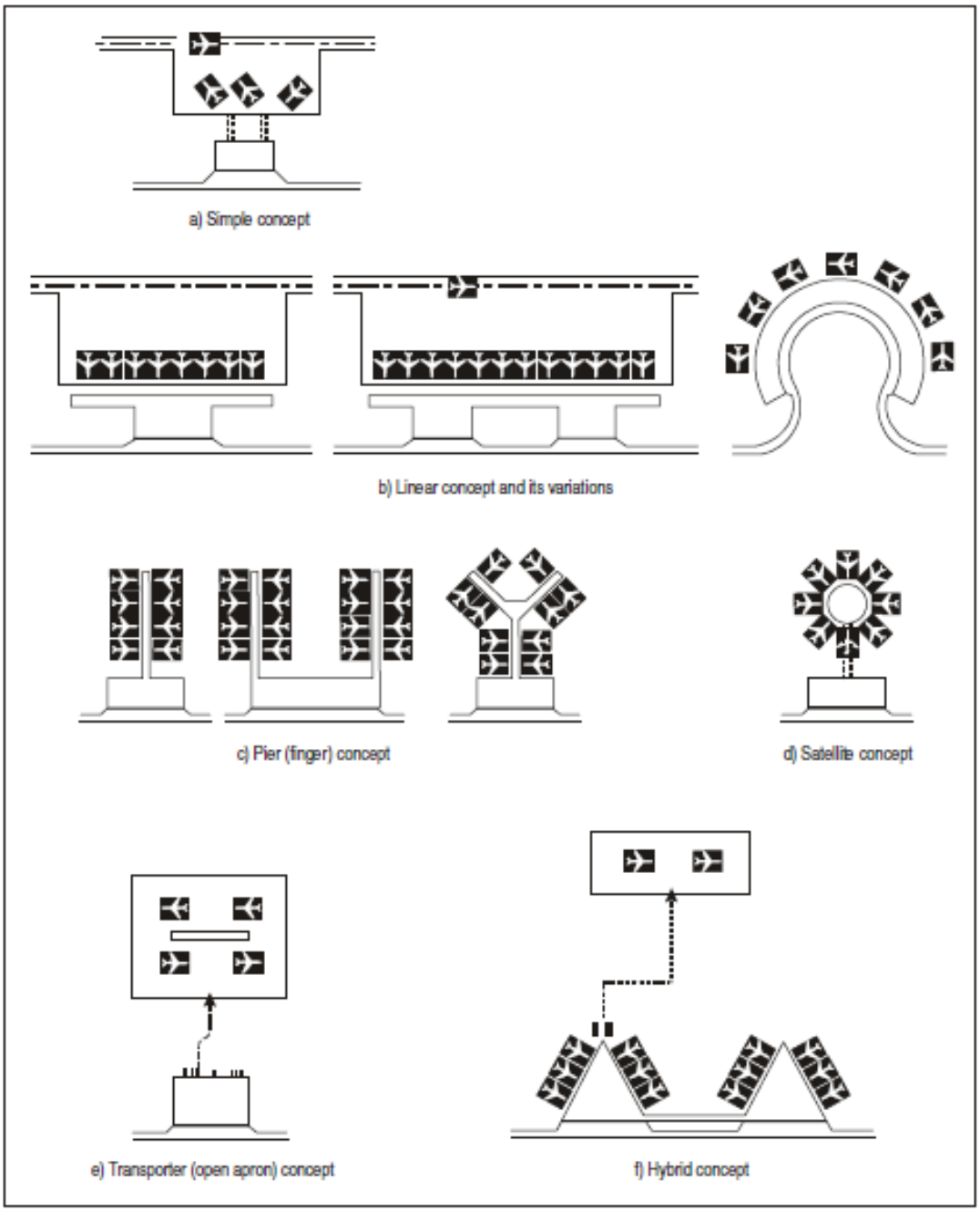

a) Simple concept
b) Linear concept and its variations
c) Pier (finger) concept
d) Satellite concept
e) Transporter (open apron) concept
f) Hybrid concept

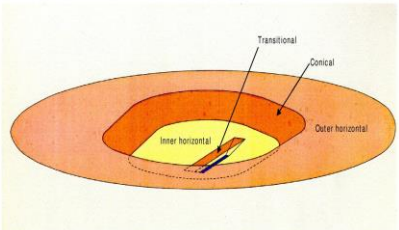
Figure 3-2. Passenger terminal apron concepts

Obstacle Limitation Surfaces *(Annex 14 Chapter 4)*

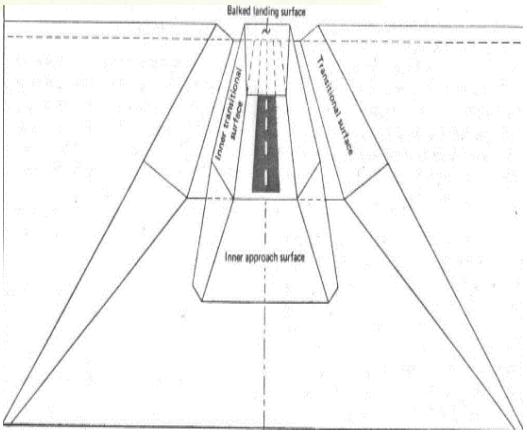
Note 1.— The objectives of the specifications in this chapter are to define the airspace around aerodromes to be maintained free from obstacles so as to permit the intended aeroplane operations at the aerodromes to be conducted safely and to prevent the aerodromes from becoming unusable by the growth of obstacles around the aerodromes. This is achieved by establishing a series of obstacle limitation surfaces that define the limits to which objects may project into the airspace.

4.2.1 The following obstacle limitation surfaces shall be established for **a non-instrument runw**ay:
- conical surface;
- inner horizontal surface;
- approach surface; and
- transitional surfaces.

4.2.7 The following obstacle limitation surfaces shall be established for a **non-precision approach** runway:
- conical surface;
- inner horizontal surface;
- approach surface; and
- transitional surfaces.



4.2.13 The following obstacle limitation surfaces shall be established for a **precision approach runway category I:**
- conical surface;
- inner horizontal surface;
- approach surface; and
- transitional surfaces.



4.2.14 **Recommendation.-** *The following obstacle limitation surfaces should be established for a precision approach runway category I:*
- inner approach surface;
- inner transitional surfaces; and
- balked landing surface.

4.2.15 The following obstacle limitation surfaces shall be established for a **precision approach runway category II or III:**
- conical surface;
- inner horizontal surface;
- approach surface and inner approach surface;
- transitional surfaces;
- inner transitional surfaces; and
- balked landing surface.

Transitional surface

4.1.13 *Description.— Transitional surface.* A complex surface along the side of the strip and part of the side of the approach surface, that slopes upwards and outwards to the inner horizontal surface.

Approach surface

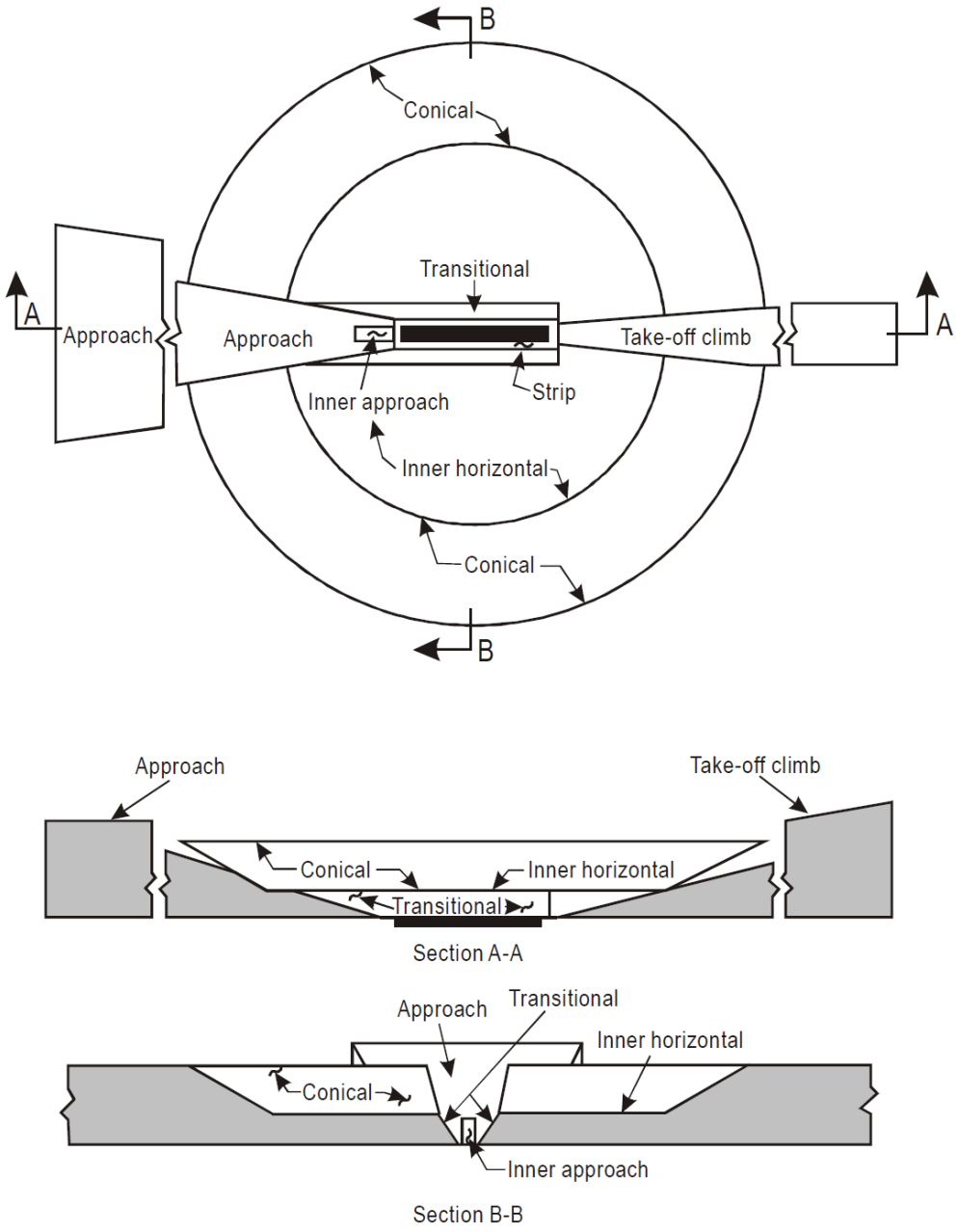
4.1.7 *Description — Approach surface.* An inclined plane or combination of planes preceding the threshold.

Inner horizontal surface

4.1.4 Description.— *Inner horizontal surface.* A surface located in a horizontal plane above an aerodrome and its environs.

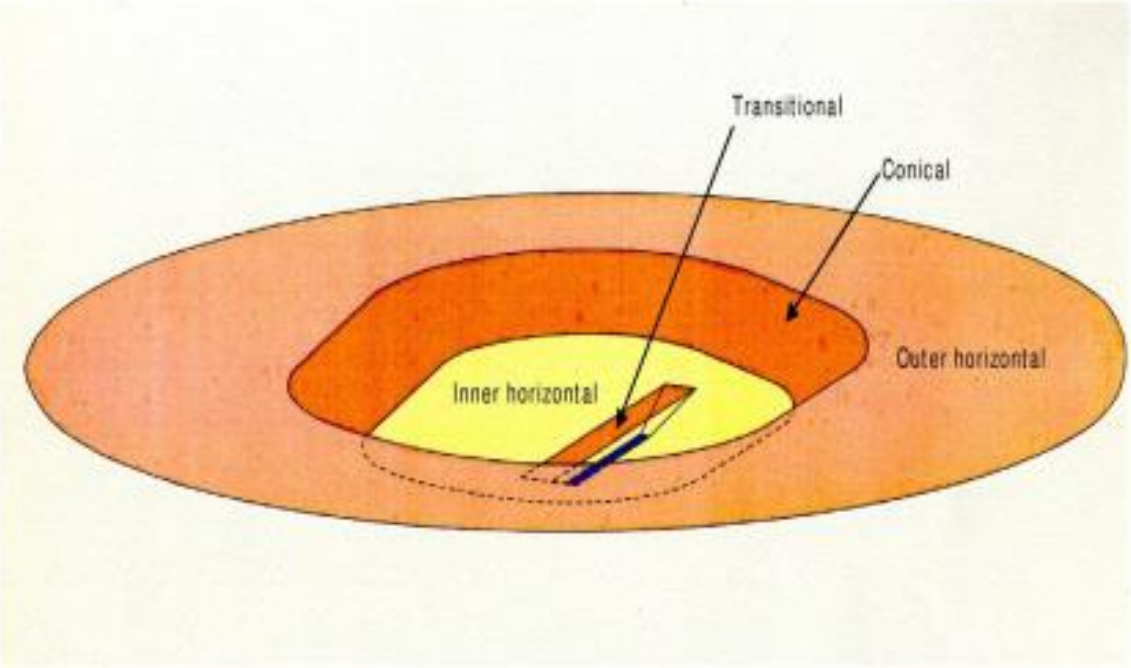
Conical surface

4.1.1 *Description.— Conical surface.* A surface sloping upwards and outwards from the periphery of the inner horizontal surface.



See Figure 4-2 for inner transitional and balked landing obstacle limitation surfaces and Attachment B for a three-dimensional view

Figure 4-1. Obstacle limitation surfaces


Transitional
Conical
Outer horizontal
Inner horizontal

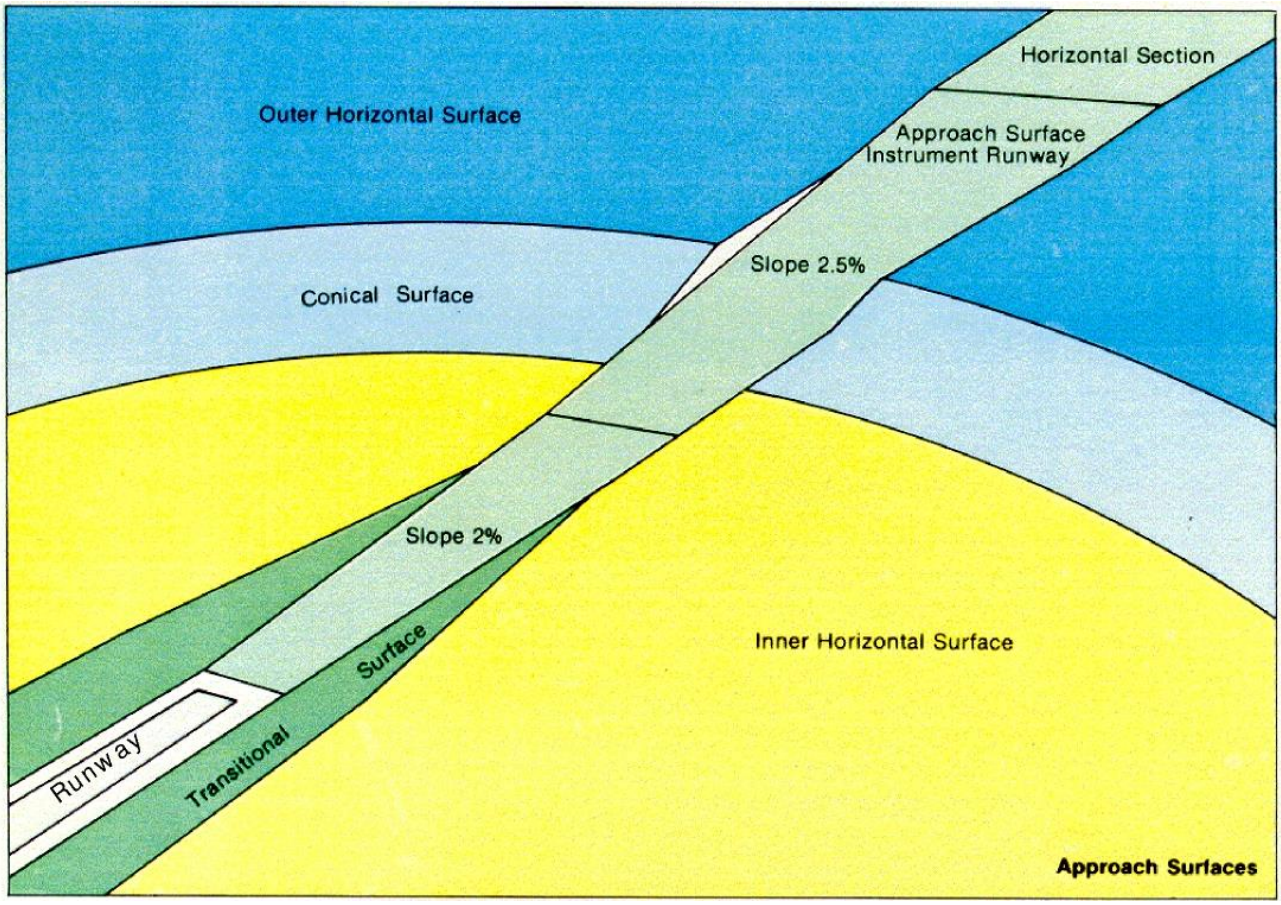

Horizontal Section
Outer Horizontal Surface
Approach Surface
Instrument Runway
Slope 2.5%
Conical Surface
Slope 2%
Surface
Inner Horizontal Surface
Runway
Transitional
Approach Surfaces

Table 4-1. Dimensions and slopes obstacle limitation surfaces – Approach runways

APPROACH RUNWAYS

	RUNWAY CLASSIFICATION									
	Non-instrument Code number				Non-precision approach Code number			Precision approach category I Code number		II or III Code number
Surface and dimensions[a]	1	2	3	4	1,2	3	4	1,2	3,4	3,4
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
CONICAL										
Slope	5%	5%	5%	5%	5%	5%	5%	5%	5%	5%
Height	35m	55m	75m	100m	60m	75m	100m	60m	100m	100m
INNER HORIZINTAL										
Height	45m	45m	45m	45m	45m	45m	45m	45m	45m	45m
Radius	2000 m	2500 m	4000 m	4000 m	3500 m	4000m	4000m	3500m	4000m	4000m
INNER APPROACH										
Width	-	-	-	-	-	-	-	90m	120m[ae]	120m
Distance from threshold	-	-	-	-	-	-	-	60m	60m	60m
Length	-	-	-	-	-	-	-	900m	900m	900m
Slope								25%	2%	2%
APPROACH										
Length of inner edge	60m	80m	150m	150m	140m	280m	280m	140m	280m	280m
Distance from threshold	30m	60m	60m	60m	60m	60m	60m	60m	60m	60m
Divergence (each side)	10%	10%	10%	10%	15%	15%	15%	15%	15%	15%
First section										
Length	1600 m	2500 m	3000 m	2500 m	2500 m	3000m	3000m	3000m	3000m	3000m
Slope	5%	4%	3.33%	2.5%	3.33%	2%	2%	2.5%	2%	2%
Second section										
Length	-	-	-	-	-	3600m[b]	3600m[b]	12000 m	3600m[b]	3600m[b]
Slope	-	-	-	-	-	2.5%	2.5%	3%	2.5%	2.5%
Horizontal section										
Length	-	-	-	-	-	8400m[b]	8400m[b]	-	8400m[b]	8400m[b]
Total length	-	-	-	-	-	15000 m	15000 m	15000 m	15000 m	15000 m
TRANSITIONAL										
Slope	20%	20%	14.3%	20%	14.3%	14.3%	14.3%	14.3%	14.3%	14.3%
INNER TRANSITIONAL										

STOLPORTS AND HELIPORTS

STOLPort (Stolport Manual Doc 9150-AN/8990 **STOLPORT** stands for **Short Take-Off and Landing Airport.** A stolport is a viable alternative in cases where runway length, location, and departure and approach path obstacles would prohibit the establishment of a conventional airport.

The Stolport manual provides guidance for the planning and establishment of stolports, unique airports designed to serve aeroplanes that have exceptional short-field performance capabilities. While "stolport" and "STOL aircraft" have not been precisely defined by ICAO, it is recognized that the capability of certain aeroplanes to operate safely in areas constrained by limited space, restricted terrain or both, offers economic and social advantages provided there are dedicated airports available.

A stolport is an airport whose physical characteristics, visual and non-visual aids and total infrastructure are created to support safe and effective public air transport in and out of densely populated urban areas as well as to and from rural areas with difficult terrain.

It should, however, be noted that stolport specifications included in the stolport manual are not applicable to altiports which are constructed in mountainous regions, though some of the STOL aircraft in use today are designed to operate from altiports. An **altiport** may be defined as a small airport in a mountainous area with a steep gradient runway, used for landing up the slope and for take-off down the slope, thereby making use of only one approach/departure area. On the other hand, the longitudinal slope of a STOL runway is flatter than even that prescribed for a runway designed for the operation of conventional aircraft and generally has approach/ departure areas at both ends of the runway.

For the purpose of design, the stolport design aeroplane is assumed to be an aeroplane that has a reference field length of 800 m or less. In size, the stolport design aeroplane is assumed to have a wingspan of up to 26 m and a main landing gear measurement of up to 9 m.

Importance of STOLPORTS in the context of Nepal

A mile of highway will take you just one mile, but a mile on runway will take you anywhere !

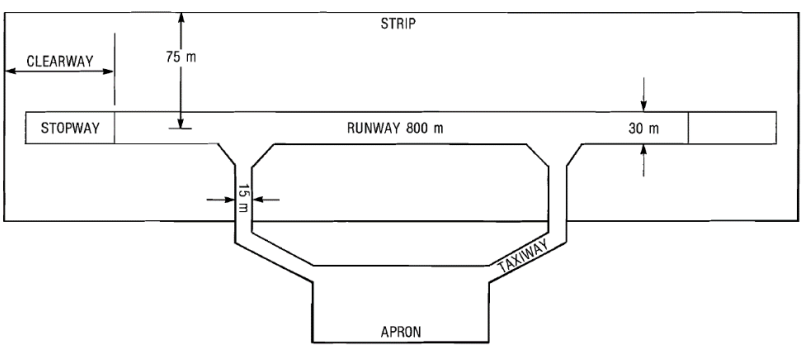
Majority of the country's land area is mountains. The geology is fragile and the terrain highly rugged. So, it is very difficult to provide effective connectivity owing the high cost of infrastructure construction. So, STOLPORTS are being effective modes of transportation in otherwise inaccessible part of the country.
STOLPORTS in Nepal help in
Promoting internal as well as international tourism.
Tourism helps reduce poverty by generating economic growth,
providing employment opportunities, increasing tax collection, and by fostering the development
-Provide access to remote areas
-Delivers humanitarian aid
-Increasing understanding of different cultures and nationalities
- Improving living standards by widening choice – easy and fast delivery of goods and consumables.
-Establish the presence of the government in remote areas.

Physical Characteristics of STOLPORTs

Runway

The length of a stolport runway should be based on take-off and landing data obtained from the aeroplane flight manual of the stolport design aeroplane and considered together with the following factors:
a whether the approaches are open or restricted;
b longitudinal slope of the proposed runway;
c elevation of the site;
d temperature and humidity of the site; and
e nature of the runway surface.

Typical STOLPORT Configuration =>



Runway width
A runway width of 23 m has been considered generally suitable for aeroplanes like the stolport design aeroplane for use in visual meteorological conditions. However, the width of a precision approach runway for such an aeroplane should be not less than 30 m.

Longitudinal and transverse slopes
Any excessive longitudinal slope on a runway will adversely affect both the landing and take-off roll of an aeroplane. For this reason wherever possible, the longitudinal slope of a stolport runway should be held to 1.0 per cent or less, not to exceed 2.0 per cent.
In cases where the longitudinal slope of a stolport runway exceeds 2.0 per cent, it may be necessary to advise the operators that operations are restricted to landing uphill and taking off downhill.
A transverse slope should not exceed 2 per cent.

Runway strip width and length
A stolport runway strip width of at least 45 m on either side of the centre line is adequate for day-time operations in visual meteorological conditions. However, for operations at night or in instrument meteorological conditions, a width of 75 m on either side of the centre line is recommended.
A stolport runway strip length of 60 m beyond the end of each runway or stopway is recommended.

Taxiways
The likely configuration of a stolport is a single runway served by a single taxiway. A runway should have sufficient entrance and exit taxiways to expedite movement of aeroplanes to and from the runway.
Where the end of a runway is not served by a taxiway, it may be necessary to provide additional pavement at the end of the runway for aeroplanes to turn .
A taxiway should be designed so that when the cockpit of the design aeroplane is over the taxiway centre line markings, the clearance distance between the outer main wheel of the aeroplane and the edge of the taxiway is not less than 3 m.

Apron
It will be necessary to provide an apron to permit the loading and unloading of passengers and cargo as well as aircraft servicing without interfering with stolport traffic.
A stolport apron's size should be sufficient to contain an adequate number of gates or parking spaces to cater to the stolport's traffic volume at its highest level.

HELIPORT

Heliport. An aerodrome or a defined area on a structure intended to be used wholly or in part for the arrival, departure and surface movement of helicopters.

Heliport Physical Characteristics:

Touchdown and lift-off area (TLOF). An area on which a helicopter may touch down or lift off.

Final approach and take-off area (FATO). A defined area over which the final phase of the approach manoeuvre to hover or landing is completed and from which the take-off manoeuvre is commenced. Where the FATO is to be used by
helicopters operated in performance class 1, the defined area includes the rejected take-off area available.

Safety area. A defined area on a heliport surrounding the FATO which is free of obstacles, other than those required for air navigation purposes, and intended to reduce the risk of damage to helicopters accidentally diverging from the FATO.

Helicopter stand. An aircraft stand which provides for parking a helicopter and where ground taxi operations are completed or where the helicopter touches down and lifts off for air taxi operations.

Helicopter clearway. A defined area on the ground or water, selected and/or prepared as a suitable area over which a helicopter operated in performance class 1 may accelerate and achieve a specific height.

Helicopter ground taxiway. A ground taxiway intended for the ground movement of wheeled undercarriage helicopters.

Helicopter taxi-route. A defined path established for the movement of helicopters from one part of a heliport to another. A taxi-route includes a helicopter air or ground taxiway which is centred on the taxi-route.

D. The largest overall dimension of the helicopter when rotor(s) are turning measured from the most forward position of the main rotor tip path plane to the most rearward position of the tail rotor tip path plane or helicopter structure.

Obstacle limitation surfaces of a Heliport

Approach Surface

Take off Climb Surface

Transitional Surface

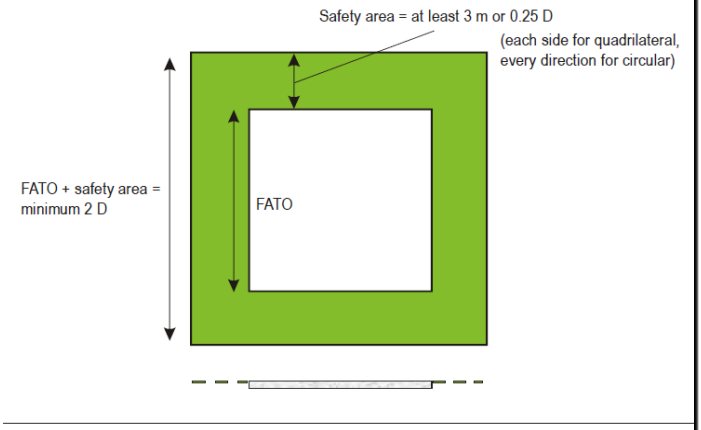

Safety area = at least 3 m or 0.25 D
(each side for quadrilateral, every direction for circular)
FATO + safety area = minimum 2 D
FATO

Figure 3-1. FATO and associated safety area

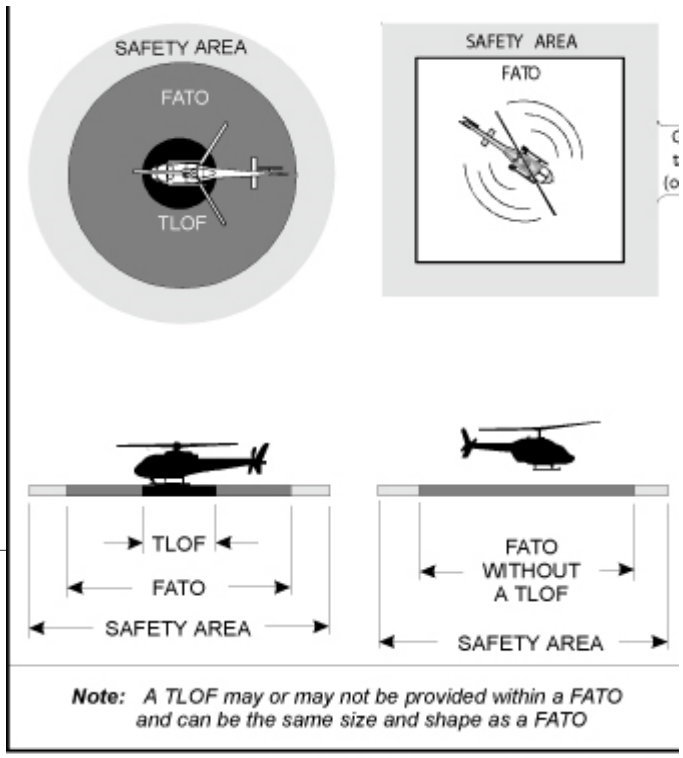


Figure 3-5. Surface level heliport operatio

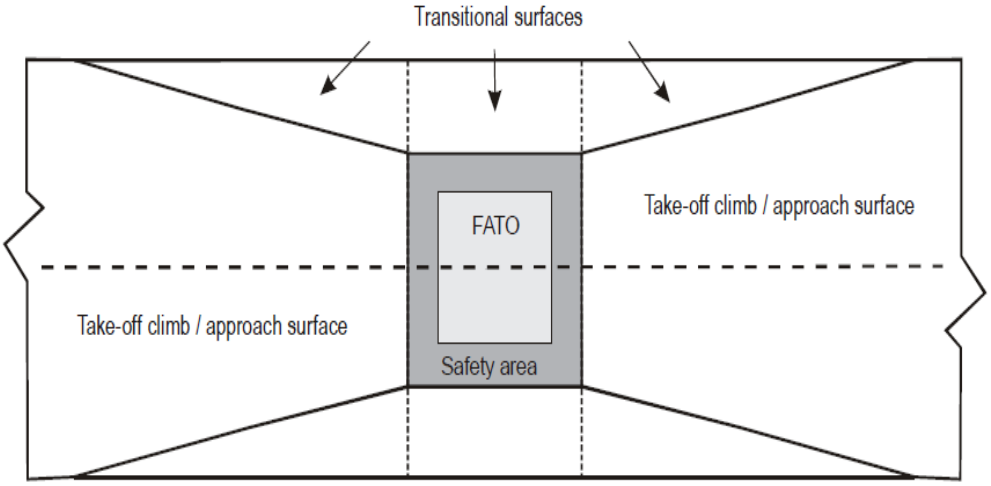


Fig : Obstacle limitation surfaces of a Heliport

AIRPORT DRAINAGE

Why Airport Drainage?

An adequate drainage system is required

1. for the removal of surface and subsurface water
2. For the safety of aircraft and for the longevity of the pavements.
3. for interception and diversion of surface and groundwater flow originating from lands adjacent to the airport

The purpose of drainage is to reduce the amount of water entering the soil and to maintain a firm, stable, and reasonably dry surface for the safe use by the aircraft

For the safety of take-off and landing, the surface of paved runways should be free from water.

Improper drainage results in the formation of puddles on the pavement surface, which can be hazardous to aircraft taking off and landing.

Objectives of Drainage

1. To protect airport territory against inflow of surface water coming from adjacent catchment basins.
2. To collect surface water from natural depression.
3. To dispose the collected water by removing it beyond airport boundary.
4. To lower the water table if necessary.
5. To remove excessive water from pervious bases of pavements.

To maintain a firm, stable, and reasonably dry surface for the safe use by aircraft, an airfield must be protected against flooding, underflooding , or both.

The principal structures providing protections against flooding and under flooding are:

1. Catch water
2. Intercepting channels
3. Intercepting drains/Bank drains
4. Dykes.

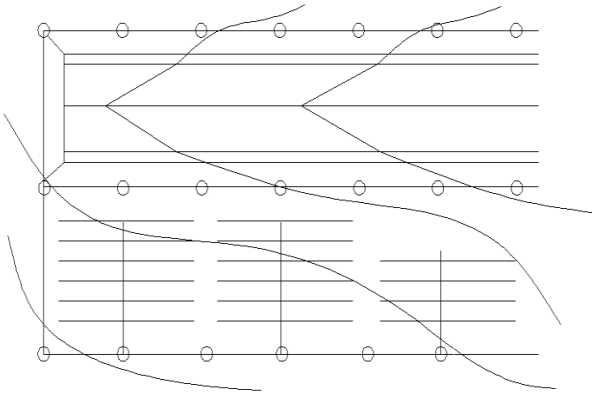


Fig: Layout of Subsurface Drainage

To avoid the unnecessary phenomena (reduction in bearing capacity of subgrade and erosion of unpaved area) due to drainage problem we have to consider following:

1. Choose the runway, taxiway, apron and parking areas that would give the best in surface drainage.
2. Provide adequate longitudinal and transverse gradient for airport pavement and unpaved shoulder.
3. Raise the pavement edge above the ground.
4. Build the impermeable pavements.
5. Provide appropriate surface and subsurface drainage .

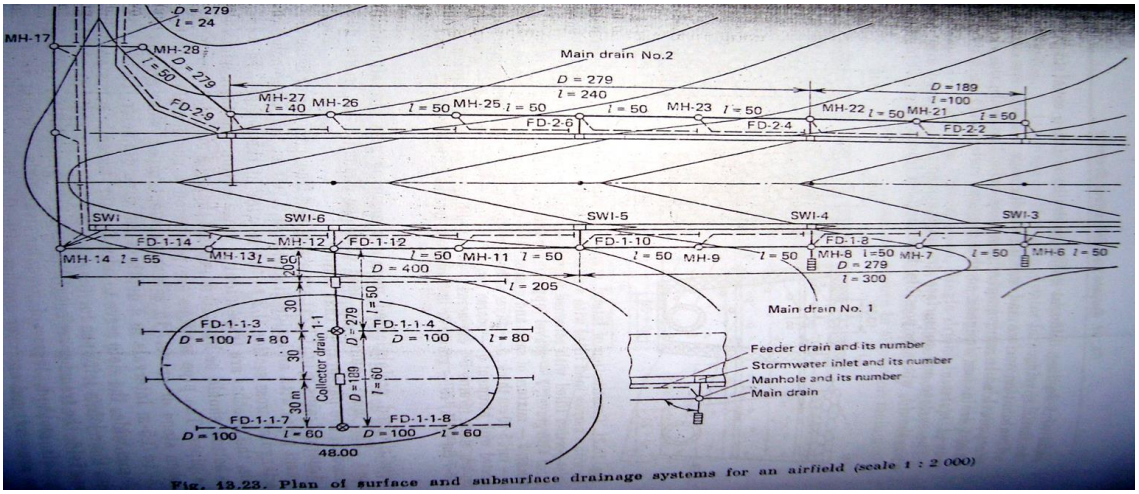


Fig. 13.23. Plan of surface and subsurface drainage systems for an airfield (scale 1 : 2 000)

Determining the Amount of Runoff by the FAA Procedure (from R Horonjeff)

The FAA analysis of airport surface drainage revolves about the solu- tion of the *rational method* expression

$$Q = CIA$$

where Q = runoff from given drainage basin, ft^3/s
C = ratio of runoff to rainfall
I = rainfall intensity for time of concentration of runoff, in/h
A = drainage area, acres

Examples and charts illustrating the FAA procedure for design have been taken largely from the FAA [2].

Time of Concentration

The *time of concentration* is defined as the time taken by water to reach the drain inlet from the most remote point in the tributary area. The *most remote point* refers to the point from which the time of flow is the greatest. The time of concentration is usually divided into two com- ponents: inlet time and time of flow. The *inlet time* is the time required for water to flow overland from the most remote point in the drain- age area to the inlet. The *time of flow* is the time taken by the water to flow from the drain inlet through the pipes to the point in the system under consideration. Sometimes the inlet time will be the time of con- centration; at other times the time of concentration will be the sum of the inlet time and time of flow.

The time of flow can be computed by the use of well-established hydraulic formulas. The inlet time is obtained largely empirically from the relationship

$$D = kT^2 \qquad (9\text{-}2)$$

Where D = distance, ft
T = time, min
k = dimensional empirical factor which is dependent on slope, roughness of terrain, extent of vegetative cover, and distance to drain inlet

Coefficient of Runoff

Application of the rational method requires the exercise of consider- able judgment on the part of the engineer. The runoff rate is variable from storm to storm and varies even during a single period of pre- cipitation. The coefficient of runoff depends on antecedent storm con- ditions, slope and type of surface, and extent of the drainage area. The range of values suggested by the FAA is indicated in Table 9-1.

For drainage basins consisting of several types of surfaces with different infiltration characteristics, the weighted runoff coefficient should be computed in accordance with

$$C = \frac{A_1C_1 + A_2C_2 + A_3C_3}{A_1 + A_2 + A_3}$$

Types of Surfaces	Factor C
For all watertight roof surfaces	0.75–0.95
For asphalt runway pavements	0.80–0.95
For concrete runway pavements	0.70–0.90
For gravel or macadam pavements	0.35–0.70
For impervious soils (heavy)*	0.40–0.65
For impervious soils with turf*	0.30–0.55
For slightly pervious soils*	0.15–0.40
For slightly pervious soils with turf*	0.10–0.30
For moderately pervious soils*	0.05–0.20
For moderately pervious soils with turf*	0.00–0.10

Coefficients of Runoff C

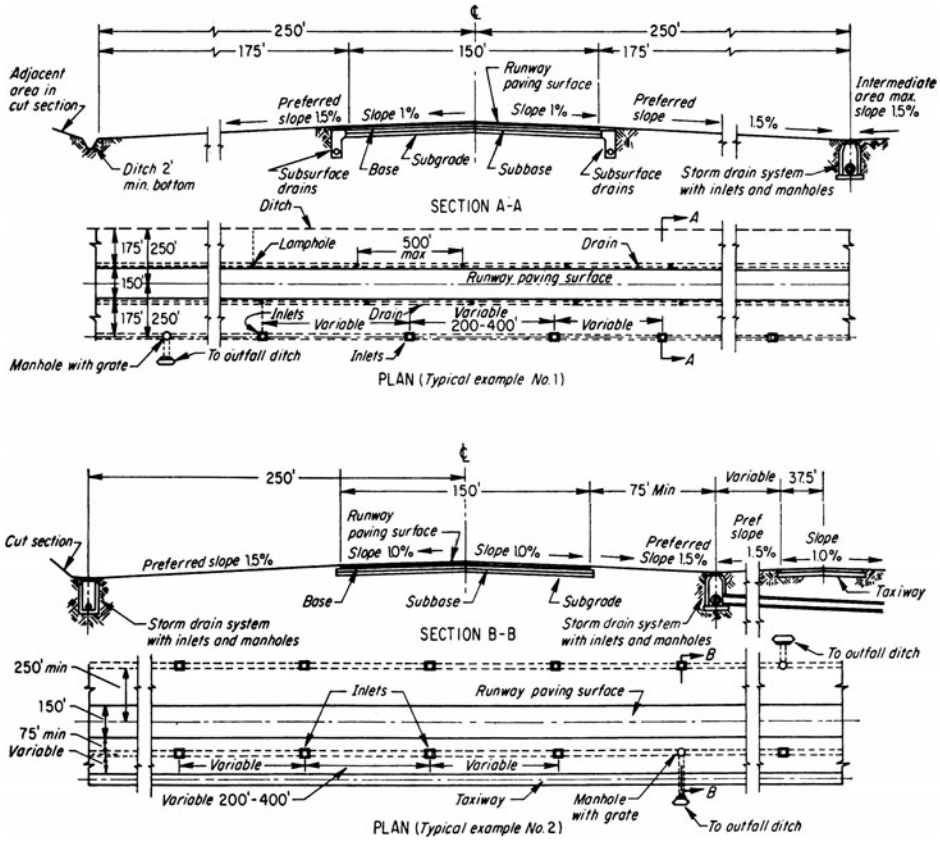


FIGURE 9-14 Recommended pavement drainage sections (*Federal Aviation Administration [2]*).

Subsurface Drainage

The functions of subsurface drainage are to (1) remove water from a base course, (2) remove water from the subgrade beneath a pave- ment, and (3) intercept, collect, and remove water flowing from springs or pervious strata.

Base drainage is normally required (1) where frost action occurs in the subgrade beneath a pavement, (2) where the groundwater is expected to rise to the level of the base course, and (3) where the pavement is subject to frequent inundation and the subgrade is highly impervious.

Subgrade drainage is desirable at locations where the water may rise beneath the pavement to less than 1 ft below the base course.

Intercepting drainage is highly desirable where it is known that subsurface waters from adjacent areas are seeping toward the airport pavements.

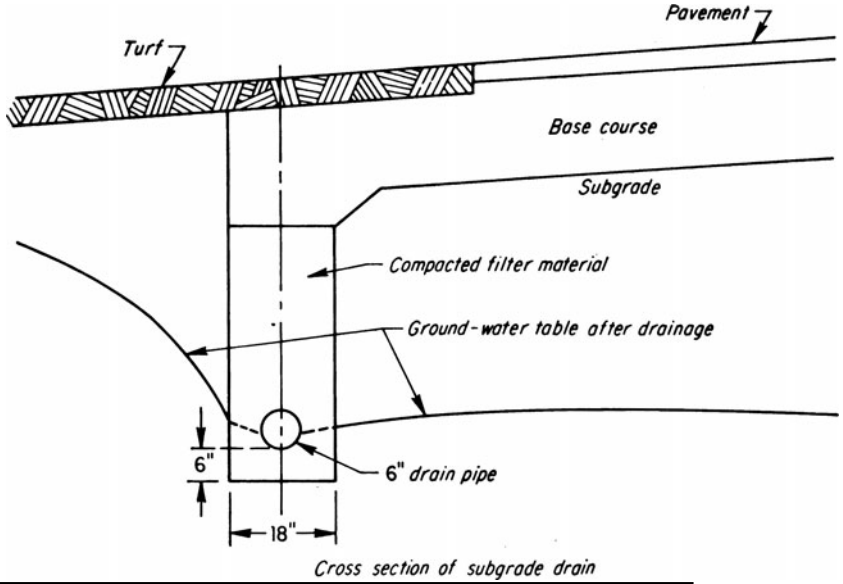


FIGURE 9-15 Subgrade subdrainage details (*Corps of Engineers*).

Methods for Draining Subsurface Water

Base courses are usually drained by installing subsurface drains adjacent to and parallel to the edges of the pavement. The pervious mate- rial in the trench should extend to the bottom of the base course, as shown in Fig. 9-15. The center of the drainpipe should be placed a minimum of 1 ft below the bottom of the base course.

Subgrades are drained by pipes installed along the edges of pavement and in some instances, where the groundwater is extremely high, underneath the pavements. The center of the subsurface drain should be placed no less than 1 ft below the level of the groundwater. When subgrade drains are installed along the edges of the pavement, they may also serve for draining the base course.

Intercepting drainage can be accomplished by means of open ditches well beyond the pavement areas. If this is not practical, then subdrains can be used.

Planning and Design of the Terminal Area

Terminal Area

The terminal area is the major interface between the airfield and the rest of the airport.

Terminal area includes the facilities for passenger and baggage processing, cargo handling and airport maintenance, operations and administration activities

The Passenger Terminal System

The passenger terminal system is the major connection between the ground access system and the aircraft. The purpose of the system is to provide the interface between the passenger airport access mode, to process the passenger for origination , termination or continuation of the air transportation trip, and convey the passenger and baggage to and from the aircraft.

Components of the Passenger Terminal System

The access interface
The processing system
The flight interface

The Access Interface

The access interface where the passenger transfers from the access mode of travel to the passenger processing component, circulation, parking, and curbside loading and unloading of passengers are the main activities that take place within this component.

The Processing System

The processing component is where the passenger is processed in preparation for starting, ending, or circulation of an air transportation trip. The primary activities that take place within this component are ticketing, baggage check-in, baggage claim, seat assignment, inspection services, and security.

The Flight Interface

The flight interface is where the passenger transfers from the processing component to the aircraft. The activities that occur here include assembly, conveyance to and from the aircraft, and aircraft loading and unloading.

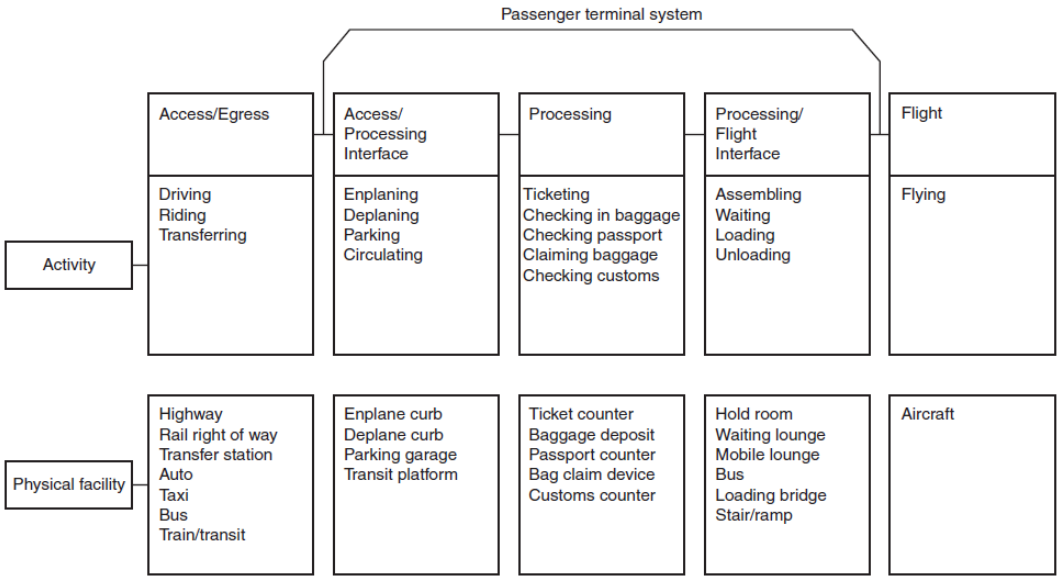


FIGURE 10-2 Components of the passenger terminal system.

The passenger terminal performs three main functions:

Change of mode (one flight to another)
Processing
Change of movement type (arrival departure by bus, taxi)

Change of mode
Few air trips are made direct from origin to destination. By their nature, air trips are mixed-mode trips, with surface access trips linked at either end to the line haul air trips. In changing from one mode to the other, the passenger physically moves through the airport terminal according the a prescribed pattern of movements. The movement patterns are accommodated by passenger circulation areas.

Processing
The terminal is a convenient point to carry out certain processes associated with the air trip. These may include ticketing and checking in the passengers, separating them from and reuniting them with their baggage, and carrying out security checks and governmental controls. This function of the terminal requires passenger processing space.

Change of movement
Although aircraft move passengers in discrete groups in what is termed "batch movements", the same passengers access the airport on an almost continuous basis, arriving and departing in small groups mainly by bus, auto, taxi, and limousine. The terminal therefore functions on the departure side as a reservoir that collects passengers continuously and processes them in batches. On the arrival side, the pattern is reversed. To perform this function, the terminal must provide passenger holding space.

Design Considerations
General design objectives:

- Development and sizing to accomplish the stated mission of the airport with the parameters defined in the master plan.
- Capability to meet the demands for the medium- and long-run time frames.
- Functional, practical, and financial feasibility.
- Maximize the use of existing facilities
- Achievement of a balanced flow between access, terminal and airfield facilities during the peak hour.
- Consideration of environmental sensitivity
- Maintenance of the flexibility to meet future requirements beyond the current planning horizon.
- Capability to anticipate and implement significant improvement in aviation technology.

The Terminal Planning Process
The evolution and development of a terminal design is performed in a series of integrated steps. These are:

- Programming
- Concept Development
- Schematic Design
- Design Development

The Programming Phase
The programming phase defines the objectives and project scope including the rationale for the initiation of the study. It includes a space requirement program, tentative implementation schedules, estimates of the anticipated level of capital investment as well as operating, maintenance and administrative costs.
Concept Development
In concept development, studies are undertaken to identify the overall arrangement of building components, functional relationships and the characteristic of the terminal building.
Schematic Design
Schematic Design translates the concept and functional relationships into plan drawing which identify the overall size, shape and location of spaces required for each function. Detailed budget estimates are prepared in schematic design so that comparisons may be made between the space requirements and costs.
Design Development

In design development, the size and character of the entire project is determined and detailed plans of the specific design and allocation of space within the complex are prepared. This phase forms the basis for the preparation of construction documents, bidding, construction and final project implementation.

Horizontal Distribution Concepts for Passenger Terminals

- Linear/Open apron
- Pier
- Satellite
- Transporter/Remote apron

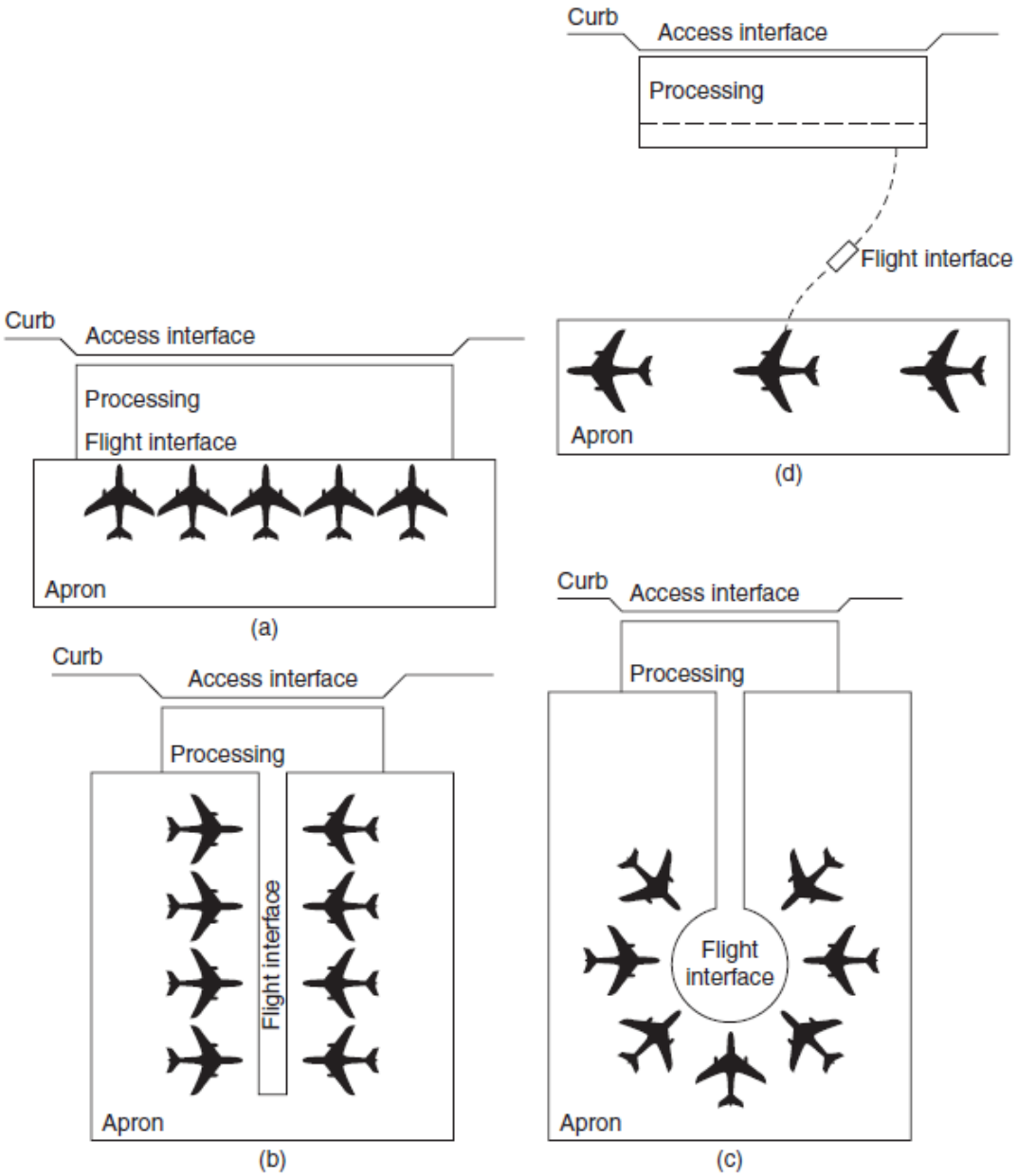


FIGURE 10-18 Horizontal distribution concepts for passenger terminals: (*a*) linear, (*b*) pier, (*c*) satellite, (*d*) transporter.

Aerodrome Pavement

Aircraft classification number (ACN): A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade category.
Aircraft classification number rating (ACNR): A number expressing the relative effect of an aircraft on a pavement for a specified standard subgrade category.
Pavement classification number (PCN): A number expressing the bearing strength of a pavement.
Pavement classification Rating (PCR): A number expressing the bearing strength of a pavement.

2.6 Strength of pavements (Annex 14)
Applicable until 27 November 2024
2.6.1 The bearing strength of a pavement shall be determined.
2.6.2 The bearing strength of a pavement intended for aircraft of apron (ramp) mass greater than 5700 kg shall be made available using the aircraft classification number — pavement classification number (ACN-PCN) method by reporting all of the following information:
a) the pavement classification number (PCN);
b) pavement type for ACN-PCN determination;
c) subgrade strength category;
d) maximum allowable tire pressure category or maximum allowable tire pressure value; and
e) evaluation method.
Note.— If necessary, PCNs may be published to an accuracy of one-tenth of a whole number.
2.6.3 The pavement classification number (PCN) reported shall indicate that an aircraft with an aircraft classification number (ACN) equal to or less than the reported PCN can operate on the pavement subject to any limitation on the tire pressure, or aircraft all-up mass for specified aircraft type(s).

2.6.4 The ACN of an aircraft shall be determined in accordance with the standard procedures associated with the ACN-PCN method.
2.6.5 For the purposes of determining the ACN, the behaviour of a pavement shall be classified as equivalent to a rigid or flexible construction.
2.6.6 Information on pavement type for ACN-PCN determination, subgrade strength category, maximum allowable tire pressure category and evaluation method shall be reported using the following codes:
a)

Pavement type for ACN-PCN determination:	*Code*
Rigid pavement	R
Flexible pavement	F

b)

Subgrade strength category:	*Code*
High strength: characterized by K =150 MN/m3 and representing all K values above 120 MN/m3 for rigid pavements, and by CBR = 15 and representing all CBR values above 13 for flexible pavements.	A
Medium strength: characterized by K =80 MN/m3 and representing a range in K of 60 to 120 MN/m3 for rigid pavements, and by CBR=10 and representing a range in CBR of 8 to 13 for flexible pavements.	B
Low strength: characterized by K = 40 MN/m3 and representing a range in K of 25 to 60 MN/m3 for rigid pavements, and by CBR=6 and representing a range in CBR of 4 to 8 for flexible pavements.	C
Ultra low strength: characterized by K =20 MN/m3 and representing all K values below 25 MN/m3 for rigid pavements, and by CBR = 3 and representing all CBR values below 4 for flexible pavements.	D

c)

Maximum allowable tire pressure category:	*Code*
Unlimited: no pressure limit	W
High: pressure limited to 1.75 MPa	X
Medium: pressure limited to 1.25 MPa	Y
Low: pressure limited to 0.50 MPa	Z

d)

Evaluation method:	*Code*
Technical evaluation: representing a specific study of the pavement characteristics and application of pavement behaviour technology.	T
Using aircraft experience: representing knowledge of the specific type and mass of aircraft satisfactorily being supported under regular use.	U

Note.— The following examples illustrate how pavement strength data are reported under the ACN-PCN method.

Example 1.— If the bearing strength of a rigid pavement, resting on a medium strength subgrade, has been assessed by technical evaluation to be PCN 80 and there is no tire pressure limitation, then the reported information would be:

PCN 80 / R / B / W / T

Example 2.— If the bearing strength of a composite pavement, behaving like a flexible pavement and resting on a high strength subgrade, has been assessed by using aircraft experience to be PCN 50 and the maximum tire pressure allowable is 1.25 MPa, then the reported information would be:

PCN 50 / F / A / Y / U

Type of Pavements:

•Flexible Pavement

–Use of bituminous materials

–Called "flexible" since the total pavement structure bends (or flexes) to accommodate traffic loads

•Rigid Pavement

–Portland cement concrete (PCC) pavements

–Called “rigid” since PCC’s high modulus of elasticity does not allow them to flex appreciably

• Composite Pavement: Combination of rigid and flexible pavements

Design steps in CBR Method:

•Determine the design aircraft

•Using the landing gear configuration select the appropriate pavement design chart.

•Determine the total thickness of pavement, using aircraft weight, annual departures and CBR value.

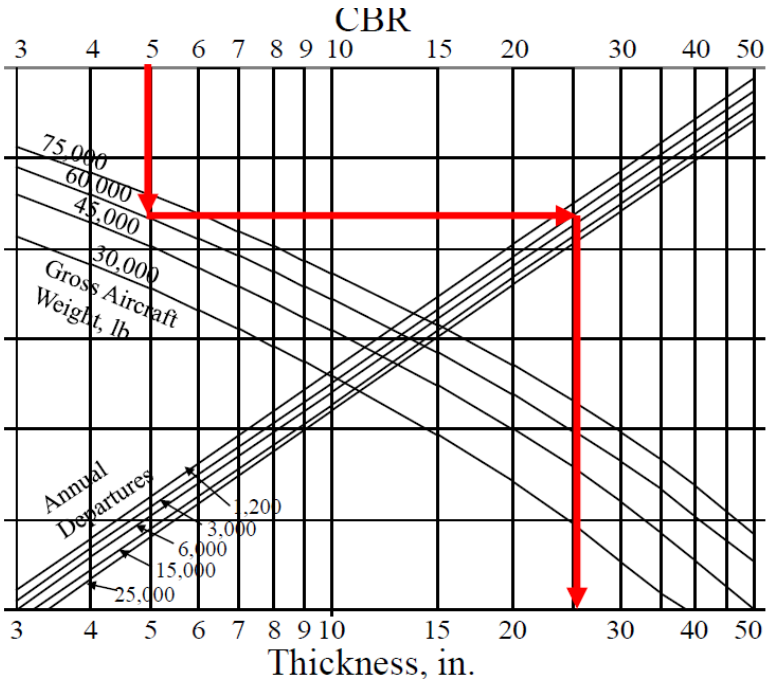
•With an assumed CBR of 20 for sub base or provided CBR value , determine the pavement thickness above sub base

•Calculate the thickness of the sub base as the difference of the two thickness calculated

•Calculate the thickness of base by subtracting the “minimum surface thickness.

Unique curve required for each gear type

Ideally need a new curve for each gear due to wheel spacing and tire pressure



FAARFIELD

An airport pavement is a complex engineering structure. Pavement analysis and design involves the interaction of four equally important components:

1. The subgrade (naturally occurring soil),
2. The paving materials (surface layer, base, and subbase),
3. The characteristics of applied loads (weight, tire pressure, location and frequency), and
4. Climate (high/low temperatures, rainfall).

Airport pavements are designed and constructed to provide adequate support for the loads imposed by aircraft and to produce a surface that is: firm, stable, smooth, skid resistant, year-round all-weather surface, free of debris or other particles that can be blown or picked up by propeller wash or jet blast.

To fulfill these performance requirements the pavement will need:

1. Structural capacity to support the imposed loads;
2. Sufficient inherent stability to withstand the abrasive action of traffic, adverse environmental conditions, and other deteriorating influences;
3. To be constructed properly using quality materials and workmanship; and
4. To be maintained with regular and routine maintenance.

Pavement Structure. A pavement structure consists of surface course, base course, subbase course, and subgrade as illustrated Figure 1-1 and Figure 1-2.

1. Surface. Surface courses typically include cement concrete or asphalt mixture.
2. Base. Base courses generally fall into two classes: unstabilized and stabilized.
   a. Unstabilized bases consist of crushed and uncrushed aggregates.
   b. Stabilized bases consist of crushed and uncrushed aggregates stabilized with cement or asphalt.
3. Subbase. Subbase courses consist of granular material, which may be unstabilized or stabilized.
4. Subgrade. Subgrade consists of natural or modified soils.

Figure 1-1. Typical Pavement Structure

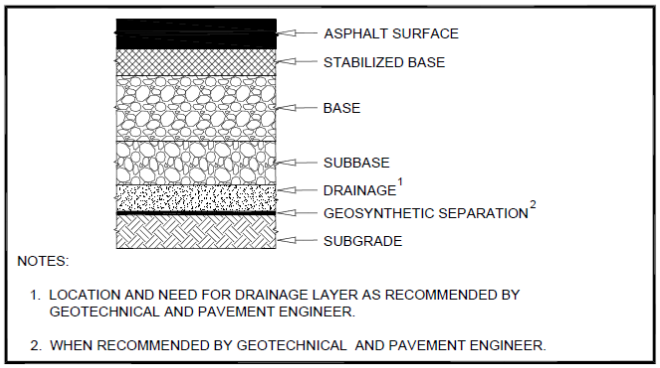
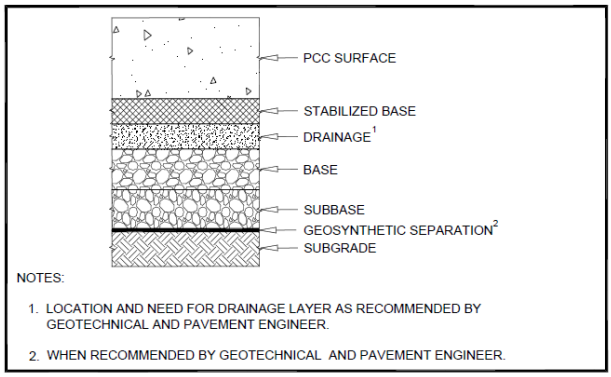


Figure 1-2. Typical Pavement Structure



FAA Pavement Design

Based on FAA -AC 150/5320-6G, Airport Pavement Design and Evaluation

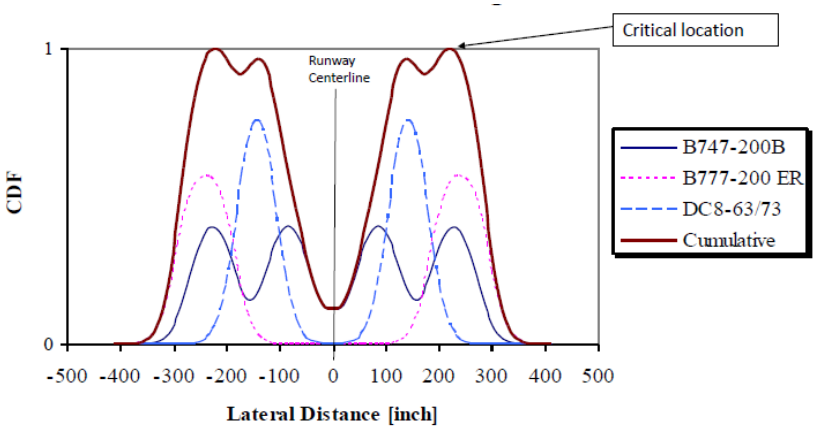
The FAA has developed the computer program FAA Rigid and Flexible Iterative Elastic Layer Design (**FAARFIELD)** to assist with pavement design. See Chapter 3 (FAA -AC 150/5320-6G) for detailed information on FAARFIELD.

- It uses new design methodologies for Rigid and Flexible pavements
- Software dependent design procedures
- Addresses modern airplane parameters
- FAARFIELD uses layered elastic and three-dimensional finite element-based design procedures for new and overlay designs of flexible and rigid pavements respectively.
- Covers standard pavement design procedures for both flexible and rigid pavement
- Applies to pavement designed for airplanes with gross weights exceeding 30,000 lbs
- Flexible Pavement Design is based on Layered Elastic Design procedure
  US Corp of Engineers CBR Method no longer used
- Rigid Pavement Design is based on 3-Dimensional Finite Element model
  Westergaard design procedure no longer used.
- Traffic Models (FAARFIELD)
  –New procedures require that ALL anticipated traffic be included in the traffic model.
  –Concept of "design aircraft" is no longer used
  –Cumulative Damage Factor (CDF) replaces need for design aircraft procedure.

Cumulative Damage Factor –Sums Damage From Each Aircraft
Based upon its unique pavement loading characteristics and Location of the main gear from centerline
DOES NOT use the "design aircraft" method of condensing all aircraft into one design model

$$CDF = \frac{\text{number of applied load repetitions}}{\text{number of allowable repetitions to failure}}$$

When CDF = 1, Design Life is Exhausted



Traffic Model –Pass to Coverage (P/C) Ratio
–Lateral movement is known as airplane wander and is modeled by statistically normal distribution.
•Standard Deviation = 30.435 inches (773 mm)
–(P/C) -The ratio of the number of trips (or passes) along the pavement for a specific point on the pavement to receive one full-load application.
–-6G utilizes new procedure for determining P/C
–For Rigid Pavement
One Coverage = One full stress application to the bottom of the PCC layer
–For Flexible Pavement
One Coverage = One repetition of maximum strain at the top of the subgrade layer
–-6G (FAARFIELD) uses the concept of "Effective Tire Width"
–Rigid Pavement –Effective width is defined at the surface of the pavement (equal to tire contact patch) (same as previous P/C procedures)
–Flexible Pavement –Effective width is defined at the surface of the subgrade layer

FROST DESIGN -3 options
–Complete Frost Protection -Remove frost susceptible materials to below frost depth
–Limited Frost Protection - Remove frost-susceptible material to 65% frost depth
- Limits frost heave to tolerable level
–Reduced Subgrade Strength
Reduce subgrade support value
Design adequate load carrying capacity for weakened condition

Pavement Evaluation and Pavement Management Systems

A pavement management system (PMS) is a mechanism for providing consistent, objective, and systematic procedures for evaluating pavement condition and for determining the priorities and schedules for pavement maintenance and rehabilitation within available resource and budgeting constraints. The pavement management system can also be used to maintain records of pavement condition and to provide specific recommendations for actions which may be required to maintain a pavement network at an acceptable condition while minimizing the cost associated with pavement maintenance and rehabilitation.

A pavement management system evaluates present pavement condition and predicts future condition through the use of a pavement condition indicator.

Pavement Deterioration:

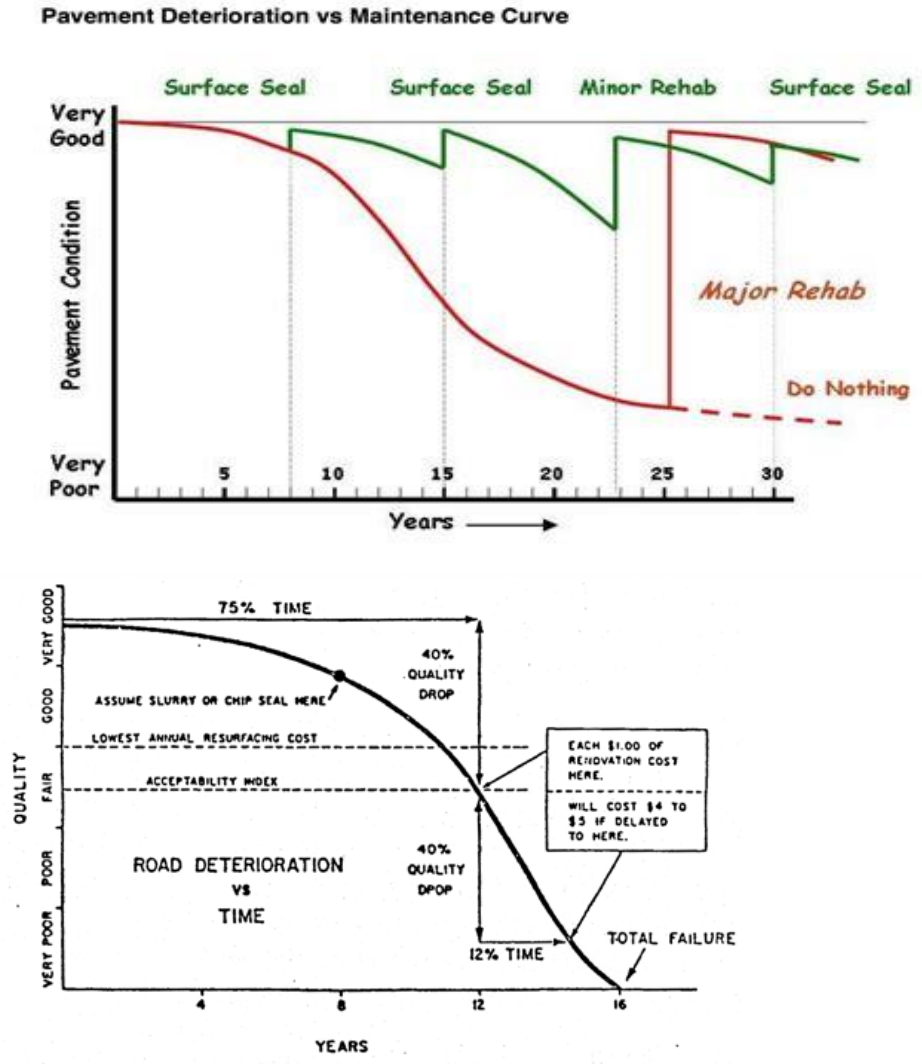


Figure 2

Objectives of PMS- use the data/indicator to timely intervene the maintenance and save the cost of maintenance.

An effective PMS for use at airports should include the following components:

1. A systematic mechanism for regularly collecting, storing, and retrieving the necessary data associated with pavement use and condition
2. An objective system for evaluating pavement condition at regular intervals
3. Procedures for identifying alternative maintenance and rehabilitation strategies
4. Mechanisms for predicting and evaluating the impact of pavement maintenance and rehabilitation strategies and alternatives on pavement condition, serviceability, and useful service life
5. Procedures for estimating and comparing the costs of various strategies and alternatives
6. Techniques for identifying the optimal strategy or alternative based upon relevant decision criteria

Pavement Evaluation

Pavement Strength Evaluation: Pavement strength evaluation is done to find out the current structural capacity of the existing pavement. So, it is essentially the reverse of design process. It also determines the remaining life of

pavement. It is useful to decide the structural ability of the existing pavement to cater the different traffic mix in the airfield pavements.

Types of Pavement Evaluation

Functional evaluation - to find out the functionality of the pavement (eg, smooth riding surface)

Structural evaluation – to find out the structural capacity of existing pavement.

Purpose: Airport pavement evaluations are necessary to assess the ability of an existing pavement to support different types, weights or volumes of airplane traffic. Evaluations may be necessary to determine the condition of existing pavements for use in the planning or design of improvements to the airports.

Pavement Strength Evaluation Process

1. Records Research
2. Site inspection
3. Sampling and testing – a) Direct sampling eg coring, boring, materials sampling
   b) Non Destructive testing eg Benkelman beam, falling weight deflectometer, ground penetration radar, infrared thermography
4. Pavement condition index (PCI 0 to 100 ratings)
5. Roughness index
6. Skid Resistance
7. Evaluation Report- analyses, findings, test results.

VISUAL AIDS FOR NAVIGATION

- **Indicators and signalling devices**
- **Markings**
- **Lights**
- **Signs**
- **Markers**

Indicators and Signalling devices

Wind direction indicator
Landing direction indicator
Signalling lamps

Markings

Runway markings
Taxiway/ Turnpad Markings
Apron Marking

Runway Markings:

Runway markings are White.

Designation Marking
Centreline Marking
Runway Side Stripe Marking
Threshold Marking/ Displaced Threshold marking
Aiming Point Marking
Touchdown Zone Marking

Taxiway Markings:

Taxiway markings are Yellow.

Taxiway Centreline marking
Taxiway Edge Marking
Runway turnpad marking
Runway/ Road holding position marking

Lights

Approach Lights
Runway Lights
Taxiway and Apron Lights

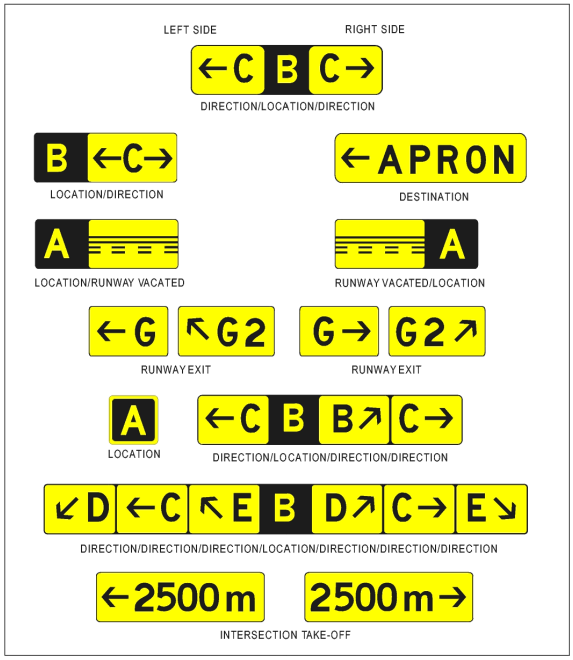
Runway Centreline and Edge Lights are white
Runway End Ligths are Red
Runway Threshodl Lights are Green
Approach Lights are White
Taxiway Centreline Ligths are Green
Taxiway Edge Lights are Blue
Obstruction Lighting are Red (Fixed, Flashing or Rotating)

Signs

Mandatory Instruction Signs
Information Signs

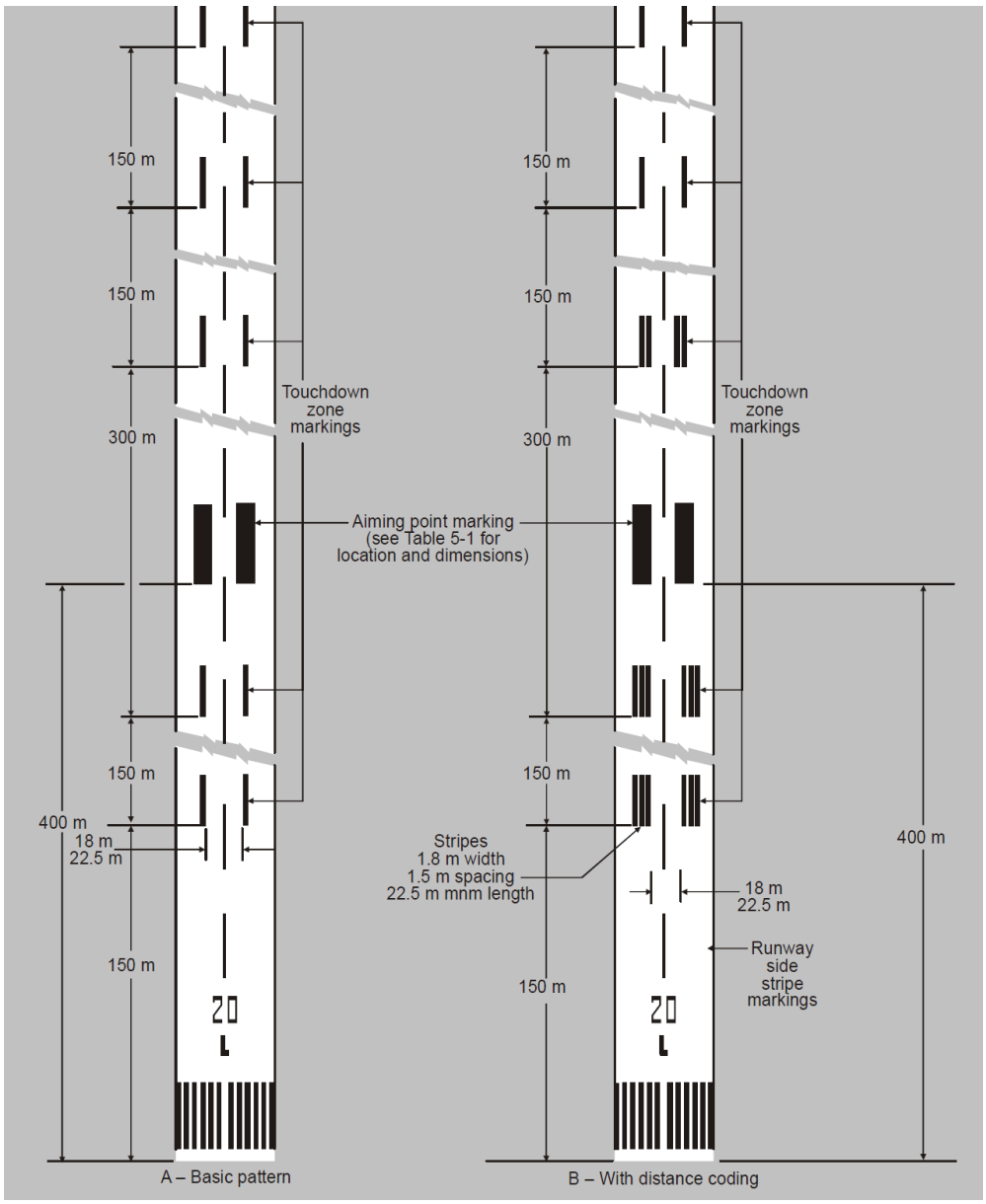
Mandatory instruction signs are placed at taxiway/ runway intersection, no entry points. These are written with white inscriptions with black outline in red background

Information Signs



Mandatory Instruction Signs

See Annex 14 for Specifications on Markings.



Airport Airside Capacity and Delay (From R Horonjeff)

Capacity and Delay Defined

The term capacity is used to designate the processing capability of a service facility over some period of time, typically defined as the maximum number of operations that a service facility can accommodate over a defined period of time. For a service facility to realize its maximum or ultimate capacity there must be a continuous demand for service. In the field of aviation, levels of demand that exceed the capacity at a given component of an airport or airspace result in system delays, where delay may be defined as the increase in time required to perform an operation from "normal" non-delayed operations.

Additional time required may come in the form of queuing, or waiting, to perform an operation, or a reduction in speed due to congestion. An operation on the airfield is often defined as a takeoff or a landing, while in the terminal an operation may be the processing of a passenger through the terminal. In the airspace, an operation may be considered an aircraft traveling through a certain sector of airspace. However, the periods of time that demand levels exist to create delays has steadily increased, particularly since the beginning of the twenty-first century. It is this increase in demand to levels that near or exceed capacity over longer periods of time that result in system delays that cause a deterioration in service quality rendering the performance of the aviation system increasingly undesirable. Therefore, airport planners and designers are faced with the problem of providing sufficient capacity to accommodate fluctuating demand with an acceptable level or quality of service. Typically, the design specifications at an airport require that sufficient capacity be provided so that a relatively high percentage of the demand will be subjected to some minimal amount of delay.

To provide sufficient capacity to service a varying demand without delay will normally require facilities which are difficult to economically justify. Therefore, in design, a level of delay acceptable from the perspectives of both the user and the operator is usually established and system components of sufficient capacity are chosen to ensure that these delay criteria are met.

Planners can compare capacity of an airport system, or any of its components, with the existing and forecast demand and ascertain whether improvements to increase capacity will be needed. Comparing the capacity of different configurations at airfields helps determine which are the most efficient. Inadequate capacity leads to increasing delays at airports. Delay is an important factor in a benefit-cost analysis and if an economic value can be placed on delay, the delay reduction savings resulting from an improvement become benefits which can be used to justify the cost of that improvement.

Capacity and Delay in Airfield Planning

In airfield planning, capacity and delay studies are performed to evaluate the ability for an airfield in its current configuration to accommodate current and future levels of demand. As demand is forecast to exceed the current airfield's capacity, airfield planners consider alternative airfield configurations, designed for additional capacity, to measure their effect on mitigating potential future delays.

As the primary objective of capacity and delay studies is to determine effective and efficient means to increase capacity and reduce delay at airports, analyses are conducted to examine the implications of the changes in the nature of the demand, the operating configurations of the airfield and the impact of facility modifications on the quality of service afforded this demand. Some of the typical applications of these analyses might include

1. The effect of alternative runway exit locations and geometry on runway system capacity
2. The impact of airfield restrictions due to noise abatement procedures, limited runway capacity, or inadequate airport navigational aids on aircraft processing rates
3. The consequences of introducing new aircraft into the fleet mix at an airport, and an examination of alternative mechanisms for servicing the mix
4. The investigation of alternative runway-use configurations on the ability to process aircraft
5. The generation of alternatives for new runway or taxiway construction to facilitate aircraft processing
6. The gains which might be realized in system capacity or delay reduction by the diversion of general aviation aircraft to reliever facilities in large air traffic hub areas

Factors That Affect Airfield Capacity

There are many factors that influence the capacity of an airfield. In general, capacity depends on the configuration of the airfield, the environment in which aircraft operate, the type and performance characteristics of the aircraft operating on the airfield, the availability and sophistication of aids to navigation, and air traffic control facilities and procedures. A listing of the most important factors includes

1. The configuration, number, spacing, and orientation of the runway system
2. The configuration, number, and location of taxiways and runway exits
3. The arrangement, size, and number of gates in the apron area
4. The runway occupancy time for arriving and departing aircraft
5. The size and mix of aircraft using the facilities
6. Weather, particularly visibility and ceiling, since air traffic rules in good weather are different than in poor weather
7. Wind conditions which may preclude the use of all available runways by all aircraft
8. Noise abatement procedures which may limit the type and timing of operations on the available runways

9. Within the constraints of wind and noise abatement, the strategy which air traffic controllers choose to operate the runway system
10. The number of arrivals relative to the number of departures
11. The number and frequency of touch and go operations by general aviation aircraft
12. The existence and frequency of occurrence of wake vortices which require greater separations when a light aircraft follows a heavy aircraft than when a heavy follows a light aircraft
13. The existence and nature of navigational aids
14. The availability and structure of airspace for establishing arrival and departure routes
15. The nature and extent of the air traffic control facilities

The most significant factor which affects runway capacity is the spacing between successive aircraft. This spacing is dependent on the appropriate air traffic rules, which are, to a large extent, functions of weather conditions and aircraft size and mix.

Aerodrome Certification

Aerodrome Certification: key to safe and efficient aerodrome operations

Aerodrome Certification is a proven and effective way of ensuring safe and efficient aerodrome operations, through a defined encompassing process which examines various components of the aerodrome, with an aim to verifying their compliance with international Standards and Recommended Practices (SARPs).

During a thorough certification process, aerodrome regulators and operators verify that the aerodrome's facilities, design, equipment and operational procedures comply with relevant SARPs, thereby ensuring safe operations and supporting optimization of aerodrome capacity and efficiency.

Provision on Annex 14

1.4.1 States shall certify aerodromes used for international operations in accordance with the specifications contained in this Annex as well as other relevant ICAO specifications through an appropriate regulatory framework.

Rule 4 of Aerodrome Certificate Regulation (2061) defines when an airport certificate must be obtained.

An operator of an aerodrome intended for international operations shall be in possession of an aerodrome certificate.

An operator of an aerodrome intended for domestic operation for public use in accordance with the national requirements, an Aerodrome Certificate shall be obtained if the maximum passenger seating capacity of the aircraft employed in the operation exceeds 30 seats as of 31st December 2012.

An operator of an aerodrome for which an Aerodrome Certificate is not required may, nevertheless, apply for an aerodrome certificate. However, such aerodromes shall be registered with the CAAN.

Aerodrome Certification
Why ?

- Ownership and management of aerodromes differs between States.
- More aerodromes being privatized.
- Standardization of procedures and technical aerodrome elements is critical; without it the necessary level of standardization is less likely.
- Certification facilitates standardization; and standardization enhances safety.
- ICAO Chicago Convention Article 15 and Annex SARPs.

Before granting an aerodrome certificate the CAA must be satisfied that:

The aerodrome operator has competent and experienced staff for the proper maintenance and operation of aerodrome;

The aerodrome operator has submitted an aerodrome manual containing all relevant information of the aerodrome;

The aerodrome facilities, services and equipment are in accordance with the requirements of the National Aerodrome Standards;

The aerodrome operating procedures make satisfactory provision for the safety of aircraft; and

An acceptable safety management system is in place at the aerodrome.

[ICAO Doc. 9774, Manual on Certification of Aerodromes]

Audit and Inspection:

As a part of Certification issuing process, a verification is done. State CAA must verify aerodrome operator's compliance with established standard which include established test and inspection procedure to ensure that aerodromes are operated in a safe manner in accordance with the regulations.

Types of Audits and Inspections

Audits:

Periodic or special audits

Review of published aerodrome data

Inspections:

- Initial/ verification
- Periodic
- Special
- Surveillance

Inspection Phases

- Preparation for the inspection
- Preinspection briefing
- Administrative inspection
- Movement area inspection
- Rescue and fire-fighting inspection
- Fuel facilities inspection
- Night inspection
- Post-inspection briefing
- Follow-up and paperwork

State Safety Program

Safety. The state in which the possibility of harm to persons or of property damage is reduced to, and maintained at or below, an acceptable level through a continuing process of hazard identification and safety risk management.

Safety management system. A systematic approach to managing safety, including the necessary organizational structures, accountabilities, policies and procedures.

SSP Concept

An SSP is defined as an integrated set of regulations and activities aimed at improving Safety. It includes specified safety activities that must be performed by the State, and regulations and directives promulgated by the State to support fulfillment of its responsibilities concerning safe and efficient delivery of aviation activities of the State. An SSP is a management system for the management of safety by the State. The implementation of an SSP must be commensurate with the size and complexity of the State's aviation system, and may require coordination among multiple authorities responsible for individual elements of civil aviation functions in the State.

SSP framework

SSP Nepal has been developed in accordance with the ICAO SSP framework that consists of four components and eleven elements:

1. State safety policy and objectives

1.1 State safety legislative framework

1.2 State safety responsibilities and accountabilities

1.3 Accident and incident investigation

1.4 Enforcement policy

2.State's safety risk management

2.1 Safety requirements for service providers SMS

2.2 Agreement on service providers' safety performance

3. State's safety assurance

3.1 Safety oversight

3.2 Safety data collection, analysis and exchange

3.3 Safety-data-driven targeting of oversight of areas of greater concern or need

4.State‘s safety promotion

4.1 Internal training, communication and dissemination of safety information

4.2 External training, communication and dissemination of safety information.

The two core operational activities of an SSP are State safety risk management and State safety assurance. These two core operational activities take place under the umbrella provided by the State safety policy and objectives and are supported by the State safety promotion.

These four components constitute the basic building blocks of an SSP, in that they represent the four overarching safety management processes that underlie the actual management system (SSP).

Relationship between an SSP and an SMS

The safety management SARPs are aimed at two audience groups: States and service providers. States are responsible for developing and establishing an SSP, whereas service providers are responsible for developing and establishing an SMS. States are responsible, as part of the activities of their SSP, to accept and oversee the development, implementation and operational performance of the service provider‘s SMS.

Model and Past Questions:

See attached sheets.